THE

# POPULAR SCIENCE MONTHLY.

**AUGUST, 1883.**

## CHANGES IN NEW ENGLAND POPULATION.

By NATHAN ALLEN, M.D., LL.D.

IN the history of a nation or a people there are sometimes important changes taking place, so gradually and quietly that they are scarcely perceptible at the time. It may require a series of years or several generations to work out the problems involved, but they may be followed with results of great magnitude.

Some changes of this character have been taking place in our New England population, which we purpose here briefly to notice. In the earlier history of New England there were few changes in the residence of her people. As agricultural pursuits constituted their principal occupation, the same farms and lands continued to a great extent in the same families from generation to generation. Prior to the Revolutionary War very little emigration took place out of New England. In the early part of the present century many persons removed to New York and some to Ohio. From 1810 to 1830 this emigration continued steadily to increase, not only to those States but to the States and Territories farther west. To such an extent had this emigration been carried on that, in 1840, the United States census reported nearly half a million of persons born in New England who were living in other States.

Whenever new lands were thrown into market by the Government, or by means of railroads, or some new mining interests, then a "Western fever" started up, and great numbers might be seen "going West." While we have no means of ascertaining the exact number removing from New England, during any one year or period of time, the United States census gives, every ten years, the *birthplace* of all people residing in every State at the time the count was made. The census of 1880 reports that the whole number born in New England

but living in other States and the Territories was 566,848. This number is made up by emigration from the different States as follows: From Massachusetts, 175,349; from Vermont, 117,590; from Connecticut, 108,797; from Maine, 93,256; from New Hampshire, 49,397; and from Rhode Island, 22,459.

From another point of view it will be seen how these natives of New England are distributed. New York has 133,272; Illinois, 53,128; California, 46,908; Iowa, 38,170; Michigan, 37,865; Wisconsin, 37,615; Minnesota, 34,636; Ohio, 32,819; Pennsylvania, 26,787; Kansas, 19,338; New Jersey, 18,148; and other States under 10,000 and much less. Vermont has sent away the largest number for its population, and New Hampshire the least. Maine and Massachusetts have sent the largest delegations to California, being three fourths of all the emigrants in that State from New England. It appears by the census that the States bordering on New York—Vermont, Massachusetts, and Connecticut—have sent over 100,000 persons to that State, while the other New England States have sent only some 20,000. The representation from New England (178,207) in the Middle States is much larger than is generally supposed. This emigration has now been going on for three fourths of a century, and it would constitute a fact of great interest if we could ascertain the number of persons born in New England who have ever removed from her borders to the Middle and Western States as well as to the Territories.

The census of 1850 shows that at that time there were 454,626; in 1860 there were 562,997; in 1870 there were 615,747, and in 1880, 566,848. It will be seen by these figures that for twenty years the number has been very stationary, the new emigrants making not quite good the number who had deceased.

It is full two generations since this emigration commenced. As nearly all those persons emigrating were between the ages of twenty and forty, great numbers must have died at various periods. The exact amount of this mortality it is impossible to ascertain, and the data for forming anything like a correct estimate are altogether too uncertain. It may have been a quarter of a million, and possibly a half million. What has been the effect of this steady and large drain of people on New England opens a question of much interest.

Without entering upon the discussion of the subject, we make two or three suggestions. It will be admitted, we presume, that those young men and women, leaving their homes, possessed, as a general thing, more physical energy and mental stamina than those remaining behind. Such a loss of physical vigor and character must have had a decided effect upon business interests as well as the present state of society. But, from another point of view, the loss may have had a more decided and lasting influence, that is, in its permanent effect upon physical and mental development. The better the principles of physiology are understood the more we discover what a pow-

erful influence physical organization has upon the character of a people. The permanent prosperity of any community depends far more upon the laws of inheritance than is generally supposed.

Let the most enterprising and promising among the young people emigrate from a place, and it must, in the course of time, have its influence. Whether the vital interests of New England have not suffered in this respect, from so many persons emigrating in the prime of life presents a question worthy of careful consideration.

INTERCHANGE OF POPULATION.—There is another change going on in these States quite different from the one described. This consists in frequent removals from one State to another.

The census of 1880 shows that Massachusetts had at that time 68,226 residents born in Maine; 54,088 born in New Hampshire; 26,869 in Vermont; 20,514 in Connecticut; and 17,067 in Rhode Island, making 186,764 persons who have removed there from other States. At the same time these five other States had 85,478 persons living in their bounds born in Massachusetts. Deduct these 85,478 from the 186,764, and Massachusetts gains over 100,000, mostly from Maine, New Hampshire, and Vermont.

There is very little migration from the other New England States to Connecticut or Rhode Island, and scarcely any from the latter to the former. Massachusetts, Connecticut, and Rhode Island, make very nearly equal exchanges, neither gaining nor losing much. These removals from one State to another are prompted from a great variety of interests, personal and local. The States most benefited by them are those employed largely in manufacturing business. These changes are carried on chiefly between villages and cities, and seldom take place in the rural or country districts. It may be said that the foreign element is largely concerned in these removals.

COUNTRY LIFE EXCHANGED FOR THE CITY.—This change is not governed at all by State lines. It commenced forty or fifty years ago, from country districts to places where trade or business demanded help. The introduction of manufactures and mechanical pursuits of various kinds, as well as the opening of railroads, created a great demand for laborers. By means of those changes and other agencies, trade and commerce became very much enlarged, and furnished employment for increased numbers.

Here and there new centers of business were formed; new villages sprang up, and large towns were converted into cities. In some parts of New England these removals have taken place to such an extent as to change the face of the country and the state of society. It commenced first in the small farming towns, and has prevailed most in places remote from markets and railroad accommodations.

The effect of such removals is especially marked in Massachusetts, as she possesses a larger number of cities, more railroad facilities, and a greater diversity of pursuits. The census shows the following facts:

That of 345 towns in Massachusetts, from 1845 to 1855, there was a decrease of population in 86 towns; that from 1855 to 1865 there was a loss in 166 towns; from 1865 to 1875 there was a loss in 142 towns, and the census of 1880 reports a loss in 143 towns.

It will be seen that the number of towns losing population varies at each census, but undoubtedly the same towns are reported as decreasing in numbers each decade. It should be stated that, in about one quarter of those towns, the loss was occasioned by a division of the town or annexing a part of it to some other place. It should also be stated that the removals from the country districts to villages and cities do not account for all these losses of population; emigration to the West, and to other distant places, does a part of the work, and so also does death.

There is another item in the account: the birth-rate has so much declined in rural districts, that scarcely any addition, if any, comes from *natural increase*. But, as the death-rate in many places exceeded the birth-rate, the thinning out of the people is not confined to Massachusetts.

In Maine, New Hampshire, and Vermont, the hill towns and many of the agricultural districts are losing more or less population—not alone by death or emigration of young people, but by the removal of whole families to more populous places. In Rhode Island and Connecticut there is not the same extent of territory, and population is more equally distributed; but still the census of Connecticut reports a decrease of population in some sixty towns in the western part of the State. Statistics show that this removal of people from the country to the city has been increasing every year; and when it will cease, or what is to be the result, time only can tell.

Agriculture as related to other Pursuits.—Connected with this decrease of population in country districts, there is one very important consideration, that it involves a change of occupation. Farming is given up for work in the store, the shop, and the mill. Within half a century the business of New England has passed through great changes.

By the censuses of 1860, 1870, and 1880, we find, instead of an increased number engaged in agriculture with the increase of population, that the number has been actually diminishing. The census divides all kinds of business or occupation into four classes: 1. Agriculture; 2. Professional and personal service; 3. Trades and transportation; and, 4. Manufactures and mechanics. An examination of the tables representing these four classes in the reports of 1870 and 1880 shows that the last three classes have increased relatively far more than the first class.

The number engaged in agriculture has fallen off in every State. Vermont and Massachusetts stand in respect to agriculture at extreme points; the former has more people engaged in farming than in all

other pursuits, while the latter has only about one tenth as many employed on the farm as are engaged in other pursuits.

Maine has the largest number of any State engaged in agriculture —about one third of her whole population—and she at the same time possesses the greatest amount of territory to cultivate. New Hampshire has half as many engaged in agriculture as in all other occupations ; Connecticut has one fourth, and Rhode Island only one tenth. The whole number in New England engaged in agriculture was 301,765, and in other pursuits, 1,268,116—more than four times as many. In 1870 the proportion was one to three.

A comparison of this table (1880) with that in the census of 1870 shows a far greater increase in the class of professional persons than in that of any other occupation or pursuit. The census of 1870 reports only 145,324, while the census of 1880 reports 349,984 persons. This increase is found in every State, though in some States greater than in others. Whether this great increase of professional persons in ten years is an indication of an improved state of society or not, is a question upon which there might be differences of opinion.

It is well understood that, fifty years ago, farming constituted the principal occupation of New England ; but, instead of maintaining its position, with a greatly increased population, it has fallen far behind other pursuits. The great additions made to her people have been absorbed in trade, in manufactures, and mechanical business. In considering this exchange of agriculture for other pursuits, a question of great interest arises : What is to be its effect upon physical organization and the permanent prosperity of a people ?

No fact is more firmly established than that agricultural pursuits are the most healthy of all, and that those engaged in them transmit *physical development* in its best estate. All experience proves that an exclusive city population tends gradually to degenerate physically, and that the stock can not be kept good from generation to generation.

It is well understood that the only conservative power that can prevent this degeneracy in cities is that their population shall be constantly replenished by recruits from the country. But it should be borne in mind that the places in the country made vacant by those removals are soon occupied by a different race of people, and that this foreign element is pretty likely to increase more and more in the farming districts of New England.

Supposing this change should generally take place in the country districts, how is the purely American stock to improve or be kept good ? It can be done only by an intermingling of the races, which is even questionable.

CHANGE IN BIRTH-RATE.—There is no one agency so closely connected with the vital interests of a people as the matter of the birth-rate. In the history of nations this has always been considered a

question of the utmost importance. To a certain extent it operates as a thermometer to show the rise and fall of national prosperity. The process of its operations may seem slow, but certain results are sure to follow.

In respect to this agency, a most surprising change has gradually been taking place in New England. Near the close of the last century, Malthus, after making a survey of all the nations on the earth, selected the United States (virtually New England, which was the most populous part) upon which to base his theory of population. Seeing that the inhabitants of these States doubled in twenty-five years by natural increase, he considered that it afforded most favorable indications of prosperity. At that time the birth-rate was high, families were large, and few were found without children.

From the first settlement at Plymouth in 1620, this prosperous state of increase continued without much change for two hundred years, but early in the present century some decline in the birth-rate commenced. It is impossible to trace the exact changes which have taken place for the last two or three generations.

In some parts of New England the precincts and towns were accustomed to keep very correct records of all births, but they were not generally printed, so no comparison of them can be made. But for thirty years or more several of the New England States have published registration reports of births in their cities and towns, so that very correct comparisons can be instituted. Without going into a detailed sketch by statistics, figures, etc., of the changes in birth-rate, we present some general statements on this subject. Forty or fifty years ago large families, numbering six, eight, ten, and twelve, were quite common; now they are rare—in fact, a large number of such families can not at the present time be found in any one neighborhood or even in a single country town. Formerly, in the rural districts of New England, there were few families having only one, two, or three children, and in case there were none it was so rare as to attract particular attention, and was considered by many a great calamity. But what a contrast is found in the present state of society! In the great majority of our American families only one, two, or three children are now found, and in very many families not *one*. And such a state of society is approved by the fashions and prevailing sentiment of the day!

As registration reports generally return the births of the foreign population in the same tables with the American, and as the term *native* is applied to all infants whose parents were born in this country, though of foreign descent, it will be at once seen how difficult it is to obtain the exact birth-rate separate of each class. Two facts are pretty well established: 1. That the birth-rate of the foreign class is more than twice as large as the strictly American; and, 2. That, in the country districts of New England settled mainly by the Americans,

it is questionable whether the birth-rate exceeds the death-rate—that is, there is no addition to the population by *natural* increase.

Should this birth-rate continue to decrease as it has for the last twenty or thirty years, the effect will become more and more manifest than it has in the past. The Board of Health for New Hampshire, having charge of the registry of births and deaths in the State, in their report just published, state an important fact bearing on this point. After carefully analyzing the births and deaths in 1880 to draw the line between the foreign and the American, the board make out that the deaths among the Americans exceed the births by eight hundred.

That is, New Hampshire lost population from this source. If this same test of birth and death rate as reported in New Hampshire should be found to apply to all the other New England States, the record would not be very creditable for the past nor encouraging for the future. In making comparison between the birth and death rate the latter must always be carefully taken into account. If the death-rate is unusually large, it affects at once the gain by natural increase. In New England the death-rate generally is not high, which is more favorable for the rate of increase. The same is true in Great Britain, but the birth-rate is much higher there than here. Thus large additions are made there to population by natural increase, far more than in New England. In France for several years the death-rate has been rather high, so that allowance must be made. As a matter of fact, the comparison with foreign nations is decidedly unfavorable to the New-Englander.

According to the latest and most authentic reports, the birth-rate of the New England States is less than that of any large European nation except France. And this birth-rate of New England is based upon both the foreign and American classes: could the latter be eliminated from the former, it would make the birth-rate of the strictly American even much lower than that of France.

It is well understood that population is steadily decreasing in certain portions of France, and that this decrease is every year extending. This decline in numbers is attracting more and more the thoughtful attention of the French *savants*, and the inquiry is made for the causes and the remedies. It may be found to resemble certain diseases, the causes of which can readily be discovered, but the remedies can not easily be applied.

Foreign Population in New England.—Of all the changes in New England, the introduction of the foreign element is the most important. The facts respecting the history of this immigration and the extent to which it has reached can be obtained, but no human sagacity can fully foresee its results. There are, however, certain features in these changes which should be carefully studied, and the developments or tendencies growing out of them should be better understood. More facts—more knowledge—are needed on this subject. What,

then, is the history of this movement? Fifty years ago, the foreign element in New England was very small. In Massachusetts the census reports that in 1830 it was only 9,620, and increased as follows: In 1840 it was 34,818; 1850, 164,448; 1860, 260,114; 1870, 357,319; and 1880, 443,402.

It should be borne in mind that these figures represent only the "foreign-born," and not their children or descendants, which would greatly increase the number. In the other New England States the whole foreign element combined is not so large as that in Massachusetts, and has not increased so fast. In Maine, in 1850, it numbered 31,450, and in 1880 it was 58,883; in New Hampshire in 1850, 13,571, and in 1880, 46,294; in Vermont, 1850, 32,931, and 1880, 40,959; in Rhode Island, 1850, 23,111, and in 1880, 73,993; and in Connecticut, 1850, 37,473, and in 1880, 129,992. The whole number of foreign-born in New England, reported by the census of 1880, was 793,122, and 360,649 of these emigrated from Ireland.

The census reports the whole population of New England, born in the United States, as 3,234,317, but large numbers reported here as *natives* are of foreign descent. It is impossible here to draw the line, but, from the best evidences before us, we should say there must be about half as many in this class as that of the foreign-born, which would increase the foreign element to 1,200,000 in New England. It may be larger. The "Catholic Directory" six years ago stated that there were at that time 890,000 souls in New England connected with that church, and the number must have since considerably increased. Then, of the 793,122 reported by the census "foreign-born," there must be a large number of Protestants—being over 100,000 emigrants from England and Scotland. The same organ also six years ago stated that "nearly 25 per cent of the population of New England is composed of Roman Catholics." The census reports the whole population of New England as 4,027,439 in 1880. At the present time (1883) the foreign element must number over 1,200,000 persons in New England.

But it is quite unequally distributed. In Massachusetts, Connecticut, and Rhode Island, it numbers more than a third of the population; but in Maine, New Hampshire, and Vermont, it is not one quarter. As the birth-rate of this class is more than twice as large as the American, the foreign element will constantly gain in numbers upon the American.

Connected with this large addition to our population composed of a different people in race, type, and character, there are several points that deserve careful consideration. A few years ago it was thought that emigration from Ireland would very much diminish, if not cease, but of late it has taken a new start, and may again flourish. Emigration from England and Scotland is sure to continue; so also from the British Provinces and Canada. But this foreign element is destined to increase hereafter more by births than by immigration.

The marriage-rate is much higher in this class than with the American. It is possible that, in the process of time, changes in the style of living, and by adopting modern fashions, the birth-rate of this class may be somewhat reduced, but certainly not at present.

Religious influences have a powerful hold upon this class of people, so that they will be restrained from violating the laws of the physical system. In process of time, there may be such a change in the organization of this people as to reduce the birth-rate. The "Catholic World" stated six years ago that "nearly 70 per cent of the births in New England were those in Catholic families." This estimate we thought at the time was too large, but with the increase of births since belonging to this class, and the addition of the births of large numbers of the foreign-born and foreign descent who are not Catholic, it will increase this percentage.

In most of the cities more than half of the births for years have been connected with the foreign element, but it was not expected that the same proportion could be found to exist in rural districts and country towns.

It does not seem possible that three fourths of all the births in New England at the present time can be classed under a foreign head, but the indications are pretty certain that such will be the case before many years, and then we shall be compelled to believe the fact. The inquiry is frequently made if the two classes do not intermarry, and what is the prospect in this direction? There are occasional intermarriages between the American, the English, the Scotch, and the emigrants from the Provinces, but not often between the Americans and the Irish. Still, cases of this kind do occur occasionally between the laboring classes, and we think they are increasing. The registration reports divide certain married parties into two classes—the foreign-born father and native mother, and *vice versa*.

The term *native* here might apply to the strictly American, but a careful examination shows that each party called native was of foreign element, so that there was no mixing of the two races. This class of marriages has been constantly increasing. In Massachusetts, according to the registration report of 1881, there were 7,386 births of this class, nearly one eighth of the whole number.

Change in Physical Organization.—The most serious evil resulting from the introduction of this foreign element is in causing a *change in the physical organization of New-Englanders*. In the case of men—that part of farming requiring hard work—those kinds of the mechanical pursuits demanding physical strength, and, in fact, nearly all manual labor out-of-doors, have already passed mainly into the hands of foreign help. This change, commencing thirty or forty years ago, has everywhere been taking place, but more rapidly of late years.

This exchange of regular physical exercise for lighter employment

and in-door work is calculated to develop nerve-tissue rather than the muscles, to impair the power of digestion, and reduce the vital forces of the system. That a course of physical degeneracy to some extent has thus been going on with New England men must now, upon thorough examination, be generally admitted.

But a change more marked and serious in its character has been taking place in female organization. Formerly all kinds of house-work and domestic duties were performed by New England women. Before foreign help could be obtained, our young women were generally employed as domestics in families. It was customary for the more wealthy and many families of the middling class, where there were no daughters, to employ one or more domestics.

In many families all the house-work was done by the daughters and mother, without any imported help. It was considered becoming and praiseworthy for all females, of whatever age or family connections, to engage on hire in domestic service.

All such employment was then considered respectable. Skill, fidelity, and success in domestic duties, were the best recommendations that any young woman could possess. Practice and public sentiment in these respects have entirely changed. Very few Yankee girls can now be persuaded at any price to engage in domestic labor. Such service is generally considered by them menial, and every kind of employment or business away from the kitchen and domestic hearth is preferred. In families where there are daughters, the hardest portion of the house-work is now performed by the mother or hired help. What are some of the effects of this change in domestic life? No kind of exercise in the world is so well calculated to develop all parts of the body in the female, and promote good health, as house-work. No study or employment whatever can fit the young girl so well for housekeeping as practical training in such duties.

In this way home and the family are pretty sure to secure a strong attachment. By these means all parts of the body are harmoniously developed; a sound constitution, good health, and long life, are secured. Instead of educating the girl in accordance with the *laws* of *her physical system*, and training her for the great practical duties of the family, from the age of ten to eighteen she is kept at school nearly all the time, so that the brain and nerves are developed at the expense of other organs. This partial and one-sided development of the body is increased and intensified in the female, by being thrown out of her natural sphere in domestic labor and family relation. Hence great multitudes of young women from fifteen to twenty-five have nothing to do, are everywhere seeking employment, and are constantly exposed to an excited or morbid state of feeling.

The ill-health of New England women is proverbial. It is less than half a century since it attracted public attention. A careful examination will show that its history and extent run almost parallel

with the high pressure in education and the neglect of house-work. The nerves and the brain have been cultivated at the expense of the muscles and physical stamina.

In this artificial state of society wants multiply and fashion has a powerful influence. A high and extravagant standard of living is set up, and young people are unwilling to commence life as their fathers or grandfathers did before them. For twenty or thirty years there has been a steady decline in the marriage-rate. There are powerful influences, starting partly from internal sources and partly from external agencies, which threaten the permanency and best interests of the family. If the laws of the human system can be so changed or violated as to defeat its primary objects, this institution must suffer and decay. There is a normal and healthy organization of the body as well as of the brain, which favors married life and the family relations.

On the other hand, there is such a thing as an abnormal development of the body and a morbid condition of the nervous system, which is decidedly unfavorable to the domestic relations; especially is this the case with females.

The law of maternity is already violated to such an extent that it is questionable whether half our New England women can properly nurse their offspring. There is a general law in nature that "*supply and demand*" go together and are co-equal, and if one fails the other is endangered. There are also decided evidences that the maternal instinct, "love of offspring," one of the strongest and holiest instincts of our nature, is fading away.

It should be borne in mind that when the harmony or balance of organization in the body is materially changed—that is, certain parts obtain an extreme development, while the functions of others become very much weakened—a similar change and derangement of action apply to the brain. The fact is well established that certain portions of the brain perform distinct and separate functions. Let that portion of the brain whose functions pertain to the family relation, and to domestic life, fail in proper development and healthy action, and supreme attention be given to the culture of the intellect and moral sentiment, and, in process of time, its effects on character will become very manifest. If this change in mental development applied only to an individual here and there, its effects on society would not be so marked or injurious; but, when the great majority of persons are affected by it, the results become far more extensive and serious in their character.

Again: the family constitutes the foundation or groundwork of all society, and, when properly established, is the most powerful agency in the world for human improvement. This institution must have its bases and supplies in the social and domestic affections, guided by the intellect and controlled by the moral sentiments. Without such a foundation it can not be made permanent, happy, and prosperous. The intellectual faculties will never alone cement and perpetuate this

institution. Some singular developments on this subject have recently been brought to public notice—that is, in matters connected with the subject of divorce.

Among no other civilized people is there such a breaking up of the family. Why should it occur here, among a people so highly educated and moral? Some attribute it to changes in legislation, but the primary causes of the evil existed before, and will continue, in spite of any changes in legislation. Its outward developments may by this means be checked, but the evil is not cured. The primary causes of these anomalous developments have, we believe, a broad and deep foundation in *physical organization*. We do not see how all the facts connected with this alarming evil can be accounted for in any other way.

There is one consideration connected with this whole subject, of vast importance, which can here only be mentioned—that is, *heredity*. The changes in organization are directly and most intimately connected with hereditary influences. The effects of such changes through the laws of inheritance are so great and far-reaching that they can not be described or measured. Judging from a physiological stand-point, the introduction of this foreign element into New England, instead of proving a blessing, may result in one of the greatest misfortunes that ever befell any race or people.

## THE ANARCHY OF MODERN POLITICS.

By W. D. LE SUEUR, B. A.

IN the Editor's Table of the April number of this magazine, there appeared what seemed to me some most excellent remarks on "The Hindrances to the Science of Politics." One of the chief of these the writer declared to be the wide-spread skepticism as to the possibility of such a science. "In no country," he added, "was this skepticism so pronounced as in the United States." Members of Congress and of the State Legislatures would all alike agree that the idea of constituting such a science was wholly chimerical. It was also stated, and pretty conclusively shown, that popular forms of government "favor and foster states of mind that exclude all considerations of a scientific nature," by calling into ascendency in a special degree "the incalculable element of personal caprice. . . . In a country where everybody is eligible to office, where the incentives to office-seeking are universal, where politics has become such a natural pastime that the whole scheme of public education is subordinated to it, personal aspirations and the interests of selfish ambition will dominate unrestricted in the management of public affairs." Offices being filled by partisans, whose lives have been largely spent in intrigue and the practice

of various vicious arts, "the first presumption in regard to an office-holder is, that he is unfit for the place. . . . These of course are not the men to appreciate the scientific elements and aspects of governmental affairs."

As I read all this, I could not help thinking how closely the writer's diagnosis of the conditions of modern political life resembled that given by Auguste Comte in the first chapter of the fourth volume of his "Philosophie Positive." But as Comte analyzes these conditions in greater detail, and treats the whole subject from the point of view of his own systematic philosophy, it occurred to me that something like a paraphrase of his views might not be unwelcome to the readers of the "Monthly," to whom the subject in its general bearings has been so well opened up in the article from which the above quotations are made.

The main *motif* of the "Positive Philosophy" is the importance, or rather the absolute necessity, if a stable and satisfactory condition of society is ever to be attained, of applying to social and political affairs those scientific principles and methods which have proved their efficacy in the physical domain. The circle of the sciences, he holds, can never be complete until there is a duly constituted science of society. So long as there exists a region, the phenomena of which are not recognized as subject to law, human thought can not assume a really integral character; while, in that outlying region, a more or less hurtful confusion must prevail. Theology has in the past assumed to rule human life, and has done so, according to a synthesis of its own. The feudal and ecclesiastical organization of society in the middle ages was the perfect exemplification of this rule. Now, however, the power of theology has been broken; it has its spokesmen still, who in its name issue mandates to the modern world; but the civilized nations have no mind to return to what would now be a house of bondage—though in its day it may have been, and in Comte's opinion was, a house of shelter. But, meantime, what are the civilized nations doing? What guidance, if any, are they now following? Comte recognizes, looking chiefly at the European nations, three doctrines, or schools, as striving for the mastery in our day—the reactionary, the revolutionary, and the stationary. The first, as its name imports, would fain bring modern society back under the theological *régime*, placing morality and government on a supernatural basis, and using the lures and terrors of another world as a means (supplemented, of course, by the hangman, in whom reactionists always have a fervent and affectionate belief) of repressing disorders in this. On this continent we have, perhaps, no school which openly avows these aims; and yet there are movements visible from time to time which show that Comte could at least find the rudiments of a reactionary party even in this land of liberty and light. Governor Benjamin F. Butler's recent Fast-day proclamation was a singularly impudent at-

tempt to browbeat the Commonwealth of Massachusetts into a more pious observance of the day than that eminent official thought would be likely to be made in the absence of such pressure. The efforts of those who wish to inoculate the constitution with a particularly pure theological virus tend in the same direction, and would make the father of Positivism smile were he alive.

The revolutionary doctrine, according to Comte's nomenclature, is that which proclaims liberty in its widest sense—an unlimited right of free inquiry, and an unlimited freedom for the people of political action. As Comte well points out, this school offers to society no definite guidance whatever—simply proclaims that all principles are to be examined and all experiments tried. That, after a certain amount of examination and experimentation, some set of principles might emerge, which society could accept as final, the revolutionary leaders are careful not to hint, lest they should be suspected of having some such set of principles in their mind, and so being at heart *doctrinaires* and perhaps even partisans of order. No, the revolutionary ideal is the negation of all trammels, change for the sake of change, a constant bubbling of the social caldron, so that no unit may remain long at the top, or long at the bottom, or long anywhere. But society can not live on change; and, in the absence of any definite doctrines of their own, the revolutionary school, when they are at the head of affairs, are compelled to make use of the principles and habitudes they find established, and even to fall back on rags and tatters belonging by right to their reactionary opponents. Thus the free-thinkers who now control the government in France are dogmatically teaching theism in the public schools. They want to give *some* kind of support to ideas of duty; and, having no coherent views of their own on the subject, they adopt, as a temporary make-shift, a theory and a synthesis which some of them would individually reject, and which none of them probably would care to be called on to expound.

The "stationary" school is that which erects into a doctrine a permanent principle of political action—the necessity of balancing reaction against revolution; holding out to society no prospect beyond that of an eternal seesaw of opposite tendencies. Disdaining all Utopias, it yet proposes to itself, as Comte observes, the very wildest of Utopias—that, namely, of securing social well-being by playing off the instinct of order against the instinct of progress. Having no principles of its own, it subsists wholly upon contradictory borrowings from the two antagonist doctrines. While it acknowledges that neither the one nor the other is fit to preside over social and political action, it thinks that, if *both* can be applied at once, all will go well. What has chiefly given vitality to this school, according to Comte, has been the example of England—which, however, has been, he asserts, an eminently misleading one; the stability of the English polity having been due to altogether exceptional circumstances, which are not and can

not be reproduced in the numerous countries to which English institutions are sought to be applied. This "essentially loyal *régime*," he further says, is approaching its end even in the country to which it is native; and English authorities, as I may have occasion to show before I close, are not wanting who share the same opinion. The polity to which the future belongs is one that will not set order against progress and progress against order, but that will make equal provision for both, and make each contribute to the other; so that order shall facilitate progress, and progress strengthen order. This is the positivist ideal.

On this continent political parties can not be said to be constituted on the lines here marked out. Owing to the absence of political privilege and the comparative uniformity of social conditions, we do not as yet see any party, of sufficient importance to be taken into account, to which the term revolutionary could be applied. For the same reasons we have no distinctly reactionary party. At the same time, taking a wider view of things, and looking rather at the constitution of *opinion* than at the structure of parties, we shall probably see that the two opposite schools mentioned by Comte are sufficiently well developed, and that the third or "stationary" school comprises a very large section of the entire population. The forces are at work, though, as the politicians say, they may not yet be "in politics." All three concur in creating and continually intensifying the confusion, skepticism, and apathy which are such marked characteristics of the political thought and action of our time. What now remains is to study the results of these general conditions in a little more detail.

By reason of their greater complexity,* and also on account of their closer contact with the whole range of human passions, social questions ought to be reserved more scrupulously than any others for intelligences, necessarily few in number, that by a severe preliminary training have been gradually prepared to work them out to satisfactory results. That this is the normal state of things we have abundant historical evidence to prove; and when, in an epoch of revolution, the situation is changed, we can only regard the case as pathological; though, possibly, as already explained, provisionally inevitable and indispensable. What, then, must have been the ravages of this social malady in a time when all individuals, however inferior their intelligence, however destitute of all suitable preparation, were summoned indiscriminately and by the most energetic modes of appeal to decide day by day, with the most deplorable levity, and without guidance or check of any kind, the most fundamental questions of politics! Instead of being surprised at the alarming divergence of

* From this point onward I shall, for the most part, be giving what at the outset I proposed to give, namely, a paraphrase rather than a translation of what Comte has written on this subject. (See "Philosophie Positive," first edition, vol. iv, p. 118 *et seq.*)

views produced by the universal propagation during the last century of this anarchical tendency, should we not rather experience a gratified wonder at discovering that, thanks to the natural good sense and intellectual moderation of men in general,* the disorder is not more complete, and that, beneath the decomposition of social maxims, certain rallying-points for humanity may still be dimly discerned? The evil has now reached such a point that all political opinions, though traceable to one or other of the sources mentioned, assume an essentially individual character, owing to the infinite number of variations produced by the intermingling of these three vicious principles. Except in cases where men are carried away by their interest in some common object or measure—which, however, each generally plans to turn to his own especial advantage—it becomes more and more impossible to get even a small number of individuals to adhere to anything like an explicit programme, or one in which vague and ambiguous language has not been employed to produce an illusory appearance of a really unattainable harmony of opinion. In the countries in which this intellectual disintegration has been, as it were, consecrated, since the commencement of the revolutionary era in the sixteenth century, by the political preponderance of Protestantism, diversities of thought, without being less intense, have been much more numerous, the popular mind having given itself over, in the absence of any energetic spiritual authority, to the indefinite discussion of religious opinions, which, of course, are at once the vaguest and the most discordant of all. No country has better verified this tendency than the United States of America, where Christianity is represented by some hundreds of sects radically at variance with one another, and daily undergoing further subdivision into shades of opinion which at last become almost purely individual. The countries that were not brought to a stand by the false "Halt!" of Protestantism do not present so great a total of vagaries; and the false opinions which have taken root in them, being more definite in their character, can be more hopefully dealt with.

The inevitable result of such an intellectual epidemic has been the gradual demolition of public morals. Such is the eminently complex character of social questions that, even when deliberate sophistry is absent, either side can be defended by extremely plausible arguments; seeing that there is no institution whatever, no matter how really indispensable to society, that has not many and serious drawbacks; while, on the other hand, the most extravagant Utopia always presents some undeniable advantages. We must not, therefore, be surprised if we see nearly all the great principles of public morality undergoing attack;

* This touch is very characteristic of Comte. He was no flatterer of "the people," and yet in the people he saw a reservoir of all the forces and all the virtues needful for the happiest regulation of the social state. The greatest philosopher, the mightiest leader of men, was in his view simply an organ of society, drawing all his strength and efficiency from the general life of society.

their defects being generally very obvious, while the facts that justify them, though in reality far more decisive, lie sometimes far below the surface, and are only brought to light by a careful and delicate analysis. But to abandon the rules of social action to the blind and arbitrary decision of an incompetent public, is really to destroy their authority. Before, therefore, there can be that convergence of opinion in relation to such matters which is indispensable to social well-being, there must be a voluntary and intentional abdication by the majority of their sovereign right of judgment—an abdication which they would probably be very willing to make if they could only find suitable organs for the exercise of the function. In the wretched routine of our political struggles, it is common to find the most judicious and honorable men accusing one another of folly or of wickedness, on the strength of the vain antagonism of their political principles; while, in every important crisis, the most opposite political principles are habitually defended by partisans of apparently equal respectability. How, then, is it possible that the influence of this double spectacle, essentially incompatible as it is with any deep and permanent conviction, should not destroy all true political morality in the minds of those alike who take part in it or who view it with admiration?

*Private* morality depends, fortunately, on many other general conditions besides fixity of opinion. Here, in ordinary cases, a true natural sentiment speaks much more powerfully than it does in regard to public relations. The disorganizing forces have, moreover, been counterbalanced to a great extent; partly by a progressive softening of manners, the result of more general intellectual culture, bringing in its train a greater familiarity with and a juster appreciation of the fine arts, and partly by the unceasing development of industry. It must be added that the rules of domestic or personal morality, as they depend on simpler conditions, and admit of easier demonstration, are naturally less endangered by the incursions of individual analysis. And yet the time has undoubtedly come when, in the private as well as in the public sphere, we are called upon to witness the lamentable results of the general unsettlement of opinion. Whether we consider the relations of the sexes, or of different ages and conditions, we shall find that the necessary elements of all satisfactory social life are directly compromised, and are daily becoming more so, by the action of a corrosive discussion, dominated by no real principles, which delivers up to hopeless uncertainty every idea of duty. The family, which the fiercest blasts of the revolutionary tempest in the last century had left untouched, is, in our day, radically assailed in its two essential foundations, marriage and inheritance. We have seen even the most general and obvious principle of individual morality, the subordination of the passions to the reason, flatly contradicted by certain would-be reformers, who, without stopping to consider the teachings of universal experience, rationally sanctioned as they are by the scientific

study of human nature, have tried to establish, as the fundamental doctrine of their improved morality, the systematic domination of the passions!

As a necessary and direct result of such disorder in the intellectual region, we see corruption erected into a recognized and indispensable means of carrying on government. So powerless have general ideas become, into such discredit have they fallen, that they no longer avail to prompt any course of action; and governments find themselves, therefore, without any other resource for securing such union of individuals as is necessary to the maintenance of a rude material order, than an almost open appeal to purely personal interests. But, were men animated by profound convictions, such a means of influence would never have to be resorted to. Even in characters of the least elevation, human nature seldom debases itself so far as to follow out a line of conduct in direct opposition to any set of convictions. We see this proved in the case of men of science: in politics, where the reign of law is not yet established, they frequently exhibit the most shameful tergiversation; while they stand firm against all temptation to abandon their anti-theological opinions for which they believe they have a scientific warrant. We thus see that the prevalent intellectual confusion not only allows the development of political corruption, but absolutely renders it necessary as a means of government, which of course can not be carried on unless a certain number of individuals can be brought to act in harmony. This fact, however, does not excuse the governments of our time for showing such a preference as they do for this particular means of influence; nor for using it, as they do, almost exclusively in their own personal interests. Bad as the *instrument* is, it might be used to better *ends* than is commonly the case, if the "practical politicians," instead of casting scorn on all attempts to establish a science of politics, were to lend such aid as they could to its elaboration. They could lend some aid by a mere change of attitude.

The political corruption of our day is not confined, however, to the direct offer by governments of material inducements for political support. We see a form of it in the awarding of distinctions and titles; and, taking a wider view, we see that all our institutions work together to call into activity the selfish ambition of all the more energetic members of the community. In this most important respect, the existing condition of society itself may be said to be eminently corrupting. At the same time that the prevalent intellectual anarchy has dissolved any public prejudices that stood in the way of unlimited individual self-assertion, the inevitable decomposition of the ancient social classification has likewise thrown down the barriers to private ambition, which is now, in the name of progress, invited to take the very highest flights. Carried along by an irresistible current, governments have had to try and meet the new demands of the time by an extravagant

multiplication of public offices, by making access to these as easy as possible, and by changing the incumbents as often as possible. Yielding in the first place to an evil necessity, they have afterward converted that necessity into a general resource of government, by trusting, as a regular thing, to the interested support of energetic and ambitious men with whom they divide the profits arising from the management of the public business. How dangerous such an expedient is from the point of view of the governments themselves, it is almost needless to point out; since it must necessarily call forth far more claims than it can satisfy, and consequently excite against the established *régime* passions far stronger than any it can evoke for its support.* If we just look at the selections for a generation or two past for the most eminent political functions, is there any reason why the great majority of our aspiring men should not conceive the hope of climbing in their turn to similar positions? Another marked feature of the times is the disposition to trust to material agencies or mere acts of legislation for the removal of evils that have their root in men's ideas and in social customs. An amendment to a constitution or a charter is proffered as a plan of political salvation; or, worse still, we are asked to rest our hopes on the substitution of this man for that in a cabinet. Meanwhile, the absence of any clear or comprehensive conception of the social future affords a career only to the most vulgar kind of ambition. At no former epoch, probably, were such chances ever offered to a presuming and adventurous mediocrity. The quality chiefly required in public life is fluency of speech; above all, a fluency which suffers no abatement if it is suddenly called on to change sides on a question. In a time of weak and wavering convictions there has naturally been a demand for representatives characterized by the vagueness of their intellectual habits and an habitual lack of fixed opinions. Unless we could hope that such a condition of things would be but transitory, it would really constitute the most shameful social degradation. That hope we may, however, entertain. If there are forces of decomposition at work, there are also—though their action may not be so conspicuous—forces of regeneration; and what is needed to give these a decisive victory is the formulation and application of a true political philosophy.

Such was the view taken by Comte, over forty years ago, of the then political situation in France and other countries enjoying constitutional *régimes*. Matters have not mended since his day: principles are more than ever discredited in political affairs; parties no longer even profess them; and government and legislation are carried on at mere hap-hazard. The great object with party managers is to get all important questions taken "out of politics," so that there may be

* How exactly this applies to the existing situation in France, and how nearly it describes the situation here, no reader will fail to remark.

nothing to embarrass the scramble for offices. The New York "Sun" lately reminded the Democrats that their business was "to elect a President," not to reform the tariff. Seek first, it says, to "elect a President," and all good things will be added unto you; but grapple with a great question like the tariff, and your opponents will surely get the better of you. Another leading organ observes that, now that the offices are no longer generally available, owing to the passage of the Pendleton civil-service bill, for the reward of political services, there remains nothing for a victorious party but "a damned barren ideality." The strength of the language, which we reproduce with absolute faithfulness, may be taken as a gauge of the disgust which the average politician feels when he sees nothing before him but a chance of doing his duty, without any special reward therefor. The novel, "Democracy," about which so much has been said, does not overstate the case in the least. When Mrs. Lee, in that lively story, tells the senator, who pays her the compliment of consulting as to the best course to take in a certain complication, to do "what is most for the public good," her counsel falls utterly pointless and abortive, simply because "the public good" had nothing whatever to do with the matter in hand. The senator himself could not pretend to tell her at what point the two things came into any kind of relation with each other. The questions involved were questions purely of self-interest, and, whatever course was taken, the country had nothing to gain.

If we turn to England, signs are not wanting that there too the absence of political principles is leading up to a crisis. "The notion," said the London "Times" recently, "that any particular set of men are in possession of principles especially calculated to promote the national well-being, or that any particular trick of government could add appreciably to the sum of happiness, is one which nowadays finds remarkably few advocates. Moreover, there is a pretty general feeling that it is very little use to rely upon principles of any kind. . . . At the present time we are not proceeding upon any principle known to either political party; and it is that fact which explains the hollowness of all political discussion, and the marked incredulity of the intelligent public toward all political professions. The fact is, that our political principles are worn out, and that the conflict which raged around them while they were vital is being mechanically carried on by men whose business it is to fight about something." When remarks like these can be made by the "leading journal," it would certainly seem as if Comte was not far wrong in his prediction that the English system would before long reveal its essential weakness. The question then arises, Can government be permanently carried on under these conditions? As Comte has remarked, the absence of principle in public life reacts upon private life; and certainly, in the latter sphere, the disorder we now witness is not what might have been expected in an age of such general enlightenment. It would seem as if, before long, those

who now profess to take things as they come, and make light of all attempts to construct a philosophy applicable to human affairs, might be compelled to humble themselves to believe that Science may have a word to say in regard to the highest order of phenomena just as she has had in regard to all orders up to the highest. If the pride of individualism should ever have such a fall as this, there is no doubt, in the mind of the present writer, that Science will respond nobly to the new call upon her, and will show how order and progress can be reconciled, and a moving equilibrium be established which shall be the proper manifestation and expression of a normal and healthy social life.

## RANK AND TITLE.

By F. D. Y. CARPENTER.

THERE is a lamentable want of method in the titular nomenclature of our public service. A first-class clerk on the civil list is a novice, receiving twelve hundred dollars a year; he becomes a fourth-class clerk, at eighteen hundred a year, only after three promotions. A lieutenant in the army is far beneath the major, but a lieutenant-general is above the major-general. Nor do the grades of lieutenant and captain in the army by any means correspond in importance with similar titles in the navy. Who can tell which is the higher officer of the navy, the chief-engineer or the engineer-in-chief? Or to whom shall we give precedence, the "chief clerk" of the Senate or the "principal clerk" of that body? The titles of the "door-keepers" of Congress convey but a faint idea of the importance and multiplicity of their duties.

During the last session of Congress an unsuccessful attempt was made to do away with the inferior titles of assistant surgeon and passed-assistant surgeon in the navy, and, in plain English, to call a surgeon a surgeon, as we call a spade a spade. The medical service of the army descends not only to the assistant surgeon, but also to the lower estate of acting assistant surgeon. But the latter official is a surgeon in every sense of the word. He has won the title by years of study and practice. His diploma gives him the right to it, and his professional experience has confirmed him in the possession of it. As such he is qualified to saw a leg off, or treat a fever; and when the Government degrades him with the title of acting assistant surgeon, which might be more properly applied to the boy who temporarily whets the knives and mixes the powders, it robs him of his reputation.

> "But he that filches from me my good name,
> Robs me of that which not enriches him,
> And makes me poor indeed."

The War Department is especially ungenerous in its designation of the civilians who are engaged upon its engineering work. Perhaps in order to keep this numerous class in the background, as far from the public appreciation as possible, and thus to increase the prominence of the engineer officers, it is ordained that, with one or two exceptions, no civilian shall be known other than as an assistant in some shape or other. Upon the geographical surveys, the topographers have been classified as topographical assistants, and the meteorologists under the cumbersome head of meteorological assistants. Since the topographers, or, more properly, geographers, conducted the triangulation, planned the surveys, and made the maps, it is difficult to see to whom they rendered assistance. Certainly not, in general, to the army officers, whose names appear conspicuously upon the maps as "executive officers and field astronomers." Though a Humboldt, or a Petermann, or a Guyot, should tender his services to the War Department as a maker of maps, he would probably be doomed to go down to posterity as a "topographical assistant." As such the public would picture him, if it thought of him at all, as sharpening the pencils and carrying the note-books of his superior officer! To the scanty recognition of civil co-operation, and to the consequent half-hearted interest and support of the civilians, is largely due the discontinuance of the surveys in question. The prestige of the Engineer Corps, upheld by the good work of the civil engineers, would have carried them through any crisis, if the latter class had seriously cared to continue the partnership longer, and if the scientific world had approved of so unequal a distribution of rewards as prevailed there.

When a man is appointed a civil engineer in the navy—there are a few of that profession employed at the several navy-yards throughout the country—he is entered upon the register under that name, he wears the imprint of his title upon his uniform, and, among his friends or in the witness-box, he has no difficulty in explaining his occupation. But in the army, or, rather, under the army, since he is not recognized as a component part of the organization, the position of the civil engineer is an exceedingly irregular one. There are several hundred civil engineers employed by the War Department upon the extensive river and harbor improvements constantly in progress. These are classed indiscriminately as assistant engineers, although they may have practical direction of the works upon which they are engaged. Sometimes their official mail comes to them addressed "U. S. Assistant Engineer," sometimes "Assistant U. S. Engineer," thus revealing a doubt or a carelessness even at headquarters concerning their appellation. As the officers of the army, by whom these things are regulated, are the greatest of sticklers in regard to their own rank, and there is no breach of military etiquette more serious than the mutilation of a title or the omission of a brevet, we would naturally expect from them greater consideration in their intercourse with civilians; and, if a man is a civil

engineer by virtue of diploma and experience, he should be allowed the simple justice of remaining such. But, if one of these anomalous beings should presume to sign himself "U. S. Civil Engineer," which is his natural and most graphic description, he is guilty of a technical falsehood, as the War Department, by recognizing such a grade as that, and then leaving it practically empty, there being but two United States civil engineers on the rolls, has debarred from its use the many other civil engineers who are equally entitled to that distinction.

There are engineers and engineers—civil, mechanical, sanitary, geographical, hydraulic, steam, locomotive, fire-department, and dozens more. For a man to say that he is an engineer conveys but a vague idea of his business. To say that he is an assistant engineer adds humiliation to vagueness. To continue, that he is an assistant United States engineer, working under the Engineer Corps of the army, would probably place him, in the popular comprehension, as an assistant to one of the soldiers of the engineer battalion. At any rate, it is not a distinction in which the American civil engineer can take great pride. To show its worthlessness for purposes of classification and description, which is the principal use of titles, we have but to say that in the pay-rolls of the Engineer Department, as published in the "United States Official Register," we find "Engineer, $60 per month," and "Assistant Engineer, $250 per month"; the former, we infer, being a steam-engineer, and the latter, it is to be presumed, a civil engineer. The civil engineers of America are not a haughty class, but still they do not wish to pass into official history in such a shape as that.

Words are principally useful for the conveyance of ideas, and when they convey no idea, or, at best, an erroneous one, they fail of their mission. A man's title is in some sense the measure of the respect which the world gives him, and justice to himself and a due regard for the world's convenience demand that it should be expressed in words that will plainly describe his occupation. In private life this is so, and when a man is called an oculist, a photographer, or a grocer, we immediately know his place and importance as a member of society. When a barber dubs himself a "tonsorial artist," and when the Government, with its red tape, assembles lawyer, physician, and statistician under the *omnium gatherum* title of "clerk," it is an offense against good English language. Since the true worker is always an enthusiast in his profession, and resents being classified under any other head, it is equally an injury to himself. How, for instance, can the lawyer of the Interior Department or the financier of the Treasury go home to his friends and describe himself as a fourth-class clerk without feeling the blush of shame upon his brow?

It was left to the Coast Survey to invent the ingeniously menial designation of "acting sub-assistant," and it is difficult to see how any man, loaded down with the ignominy of such a name, could ever do good work or rise to better things. Whatever may be the duties of

any participant in the excellent work of that organization, he can not, in good English, be less than an assistant, and yet only officers of the highest attainable grade are entitled to the latter distinction. Still below the assistants and sub-assistants come the aids, young officers whose inferiority of position is mollified by the possession of a title synonymous in meaning with that of their superiors, and therefore equally respectable in the popular comprehension. Such is the poverty of this nomenclature that it carries with it only the general idea of subordination. Surely it would not be impossible to devise some system of titles which would at the same time convey some hint of the duties and the relative rank of the scientists of that body.

## ON RADIATION.*

By JOHN TYNDALL, F.R.S.

SCIENTIFIC discoveries are not distributed uniformly in time. They appear rather in periodic groups. Thus, in the first two years of this century, among other gifts presented by men of science to the world, we have the voltaic pile; the principle of Interference, which is the basis of the undulatory theory of light; and the discovery by William Herschel of the dark rays of the sun.

Directly or indirectly, this latter discovery heralded a period of active research on the subject of radiation. Leslie's celebrated work, "On the Nature of Heat," was published in 1804, but he informs us, in the preface, that the leading facts which gave rise to the publication presented themselves in the spring of 1801. An interesting but not uncommon psychological experience is glanced at in this preface. The inconvenience of what we call ecstasy, or exaltation, is that it is usually attended by undesirable compensations. Its action resembles that of a tidal river, sometimes advancing and filling the shores of life, but afterward retreating and leaving unlovely banks behind. Leslie, when he began his work, describes himself as "transported at the prospect of a new world emerging to view." But further on the note changes, and before the preface ends he warns the reader that he may expect variety of tone, and perhaps defect of unity, in his disquisition. The execution of the work, he says, proceeded with extreme tardiness; and, as the charm of novelty wore off, he began to look upon his production with a coolness not usual in authors.

The ebb of the tide, however, was but transient; and to Leslie's ardor, industry, and experimental skill, we are indebted for a large body of knowledge in regard to the phenomena of radiation. In the prosecution of his researches he had to rely upon himself. He devised

* A "Friday Evening Discourse," recently delivered in the Royal Institution.

his own apparatus, and applied it in his own way. To produce radiating surfaces, he employed metallic cubes, which to the present hour are known as Leslie's cubes. The different faces of these cubes he coated with different substances, and, filling the cubes with boiling water, he determined the emissive powers of the substances thus heated. These he found to differ greatly from each other. Thus, the radiation from a coating of lamp-black being called 100, that from the uncoated metallic surface of his cube was only 12. He pointed out the reciprocity existing between radiation and absorption, proving that those substances which emit heat copiously absorb it greedily. His thermoscopic instrument was the well-known differential-thermometer invented by himself. In experiment Leslie was very strong, but in theory he was not so strong. His notions as to the nature of the agent whose phenomena he investigated with so much ability are confused and incorrect. Indeed, he could hardly have formed any clear notion of the physical meaning of radiation before the undulatory theory of light, which was then on its trial, had been established.

A figure still more remarkable than Leslie occupied the scientific stage at the same time—namely, the vigorous, penetrating, and practical Benjamin Thompson, better known as Count Rumford, the originator of the Royal Institution. Rumford traversed a great portion of the ground occupied by Leslie, and obtained many of his results. As regards priority of publication, he was obviously discontented with the course which things had taken, and he endeavored to place both himself and Leslie in what he supposed to be their right relation to the subject of radiant heat. The two investigators were unknown to each other personally, and their differences hardly rose to scientific strife. There can hardly, I think, be a doubt that each of them worked independently of the other, and that, where their labors overlap, the honor of discovery belongs equally to both.

The results of Leslie and Rumford were obtained in the laboratory; but the walls of a laboratory do not constitute the boundary of its results. Nature's hand specimens are always fair samples, and, if the experiments of the laboratory be only true, they will be ratified throughout the universe. The results of Leslie and Rumford were in due time carried from the cabinet of the experimenter to the open sky, by Dr. Wells, a practicing London physician. And here let it be gratefully acknowledged that vast services to physics have been rendered by physicians. The penetration of Wells is signalized among other things by the fact recorded by the late Mr. Darwin, that, forty-five years before the publication of the "Origin of Species," the London doctor had distinctly recognized the principle of Natural Selection, and that he was the first who recognized it. But Wells is principally known to us through his "Theory of Dew," which, prompted by the experiments of Leslie and Rumford, and worked out by the most refined and conclusive observations on the part of Wells himself, first

revealed the cause of this beautiful phenomenon. Wells knew that through the body of our atmosphere invisible aqueous vapor is everywhere diffused. He proved that grasses and other bodies on which dew was deposited were powerful emitters of radiant heat; that, when nothing existed in the air to stop their radiation, they became self-chilled; and that while thus chilled they condensed into dew the aqueous vapor of the air around them. I do not suppose that any theory of importance ever escaped the ordeal of assault on its first enunciation. The theory of Wells was thus assailed; but it has proved immovable, and will doubtless continue so to the end of time.

The interaction of scientific workers causes the growth of science to resemble that of an organism. From Faraday's tiny magneto-electric spark, shown in this theatre half a century ago, has sprung the enormous practical development of electricity at the present time. Thomas Seebeck in 1822 discovered thermo-electricity, and eight years subsequently bars of bismuth and antimony were first soldered together by Nobili so as to form a thermo-electric pile. In the self-same year Melloni perfected the instrument and proved its applicability to the investigation of radiant heat. The instrumental appliances of science have been well described as extensions of the senses of man. Thus the invention of the thermopile vastly augmented our powers over the phenomena of radiation. Melloni added immensely to our knowledge of the transmission of radiant heat through liquids and solids. His results appeared at first so novel and unexpected that they excited skepticism. He waited long in vain for a favorable report from the Academicians of Paris; and finally, in despair of obtaining it, he published his results in the "Annales de Chimie." Here they came to the knowledge of Faraday, who, struck by their originality, brought them under the notice of the Royal Society, and obtained for Melloni the Rumford medal. The medal was accompanied by a sum of money from the Rumford fund; and this, at the time, was of the utmost importance to the young political exile, reduced as he was to penury in Paris. From that time until his death, Melloni was ranked as the foremost investigator in the domain of radiant heat.

As regards the philosophy of the thermopile, and its relation to the great doctrine of the conservation of energy, now everywhere accepted, a step of singular significance was taken by Peltier in 1834. Up to that time it had been taken for granted that the action of an electric current upon a conductor through which it passed was always to generate heat. Peltier, however, proved that, under certain circumstances, the electric current generated cold. He soldered together a bar of antimony and a bar of bismuth, end to end, thus forming of the two metals one continuous bar. Sending a current through this bar, he found that when it passed from antimony to bismuth across the junction, heat was always there developed, whereas, when the direction of the current was from bismuth to antimony, there was a

development of cold. By placing a drop of chilled water upon the junction of the two metals, Lenz subsequently congealed the water to ice by the passage of the current.

The source of power in the thermopile is here revealed, and a relation of the utmost importance is established between heat and electricity. Heat is shown to be the nutriment of the electric current. When one face of a thermopile is warmed, the current produced, which is always from bismuth to antimony, is simply heat consumed and transmuted into electricity.

Long before the death of Melloni, what the Germans call "Die Identitäts-Frage," that is to say, the question of the identity of light and radiant heat, agitated men's minds and spurred their inquiries. In the world of science men differ from each other in wisdom and penetration, and a new theoretic truth has always at first the minority on its side. But time, holding incessantly up to the gaze of inquirers the unalterable pattern of Nature, gradually stamps that pattern on the human mind. For twenty years Henry Brougham was able to quench the light of Thomas Young, and to retard, in like proportion, the diffusion of correct notions regarding the nature and propagation of radiant heat. But such opposing forces are, in the end, driven in, and the undulatory theory of light being once established, soon made room for the undulatory theory of radiant heat. It was shown by degrees that every purely physical effect manifested by light was equally manifested by the invisible form of radiation. Reflection, refraction, double refraction, polarization, magnetization, were all proved true of radiant heat, just as certainly as they had been proved true of light. It was at length clearly realized that radiant heat, like light, was propagated in waves through that wondrous luminiferous medium which fills all space, the only real difference between them being a difference in the length and frequency of the ethereal waves. Light, as a sensation, was seen to be produced by a particular kind of radiant heat, which possessed the power of exciting the retina.

And now we approach a deeper and more subtile portion of our subject. What, we have to ask, is the origin of the ether-waves, some of which constitute light, and all of which constitute radiant heat? The answer to this question is that the waves have their origin in the vibrations of the ultimate particles of bodies. But we must be more strict in our definition of ultimate particles. The ultimate particle of water, for example, is a *molecule*. If you go beyond this molecule and decompose it, the result is no longer water, but the discrete *atoms* of oxygen and hydrogen. The molecule of water consists of three such atoms held tightly together, but still capable of individual vibration. The question now arises, Is it the molecules vibrating as wholes, or the shivering atoms of the molecules, that are to be

considered as the real sources of the ether-waves? As long as we were confined to the experiments of Leslie, Rumford, and Melloni, it was difficult to answer this question. But, when it was discovered that gases and vapors possessed—in some cases to an astonishing extent—the power both of absorbing and radiating heat, a new light was thrown upon the question.

You know that the theory of gases and vapors, now generally accepted, is that they consist of molecular or atomic projectiles darting to and fro, clashing and recoiling—endowed, in short, with a motion not of vibration, but of translation. When two molecules clash, or when a single molecule strikes against its boundary, the first effect is to deform the molecule, by moving its atoms out of their places. But gifted as they are with enormous resiliency, the atoms immediately recover their positions, and continue to quiver in consequence of the shock. Held tightly by the force of affinity, they resemble a string stretched to almost infinite tension, and therefore capable of generating tremors of almost infinite rapidity. What we call the heat of a gas is made up of these two motions—the flight of the molecules through space, and the quivering of their constituent atoms. Thus does the eye of Science pierce to what Newton called "the more secret and noble works of Nature," and make us at home amid the mysteries of a world lying in all probability vastly farther beyond the range of the microscope than the power of the microscope, at its maximum, lies beyond that of the unaided eye.

The great principle of radiation, which affirms that all bodies absorb the same rays that they emit, is now a familiar one. When, for example, a beam of white light is sent through a yellow sodium-flame, produced by a copious supply of sodium-vapor, the yellow constituent of the white beam is stopped by the yellow flame, and, if the beam be subsequently analyzed by a prism, a black band is found in the place of the intercepted yellow band of the spectrum. We have been led to our present theoretic knowledge of light by a close study of the phenomena of sound, which in the present instance will help us to a conception of the action of the sodium-flame. The atoms of sodium-vapor synchronize in their vibrations with the particular waves of ether which produce the sensation of yellow light. The vapor, therefore, can take up or absorb the motion of those waves, as a stretched piano-string takes up or absorbs the pulses of a voice pitched to the note of the string. This action of sodium-vapor may be shown by an experiment which startled and perplexed me on first making it, more than twenty years ago. The spectra of incandescent metallic vapors are, as you know, not continuous, but formed of brilliant bands. Wishing, in 1861, to obtain the brilliant yellow band produced by incandescent sodium-vapor, I placed a bit of sodium in a carbon crucible, and volatilized it by a powerful voltaic current. A feeble spectrum overspread the screen, from which it was thought the sodium band would stand

out with dominant brilliancy. To my surprise, at the very point where I expected this brilliant band to appear, a band of darkness took its place. By humoring the voltaic arc a little, the darkness vanished, and the bright band which I had sought at the beginning was obtained. On reflection the cause was manifest. The first ignition of the sodium was accompanied by the development of a large amount of sodium-vapor, which spread outward and surrounded, as a cool envelope, the core of intensely heated vapor inside. By the cool vapor the rays from the hot were intercepted, but on lengthening the arc the outer vapor in great part was dispersed, and the rays passed to the screen. This relation as to temperature was necessary to the production of the black band, for, were the outside vapor as hot as the inside, it would, by its own radiation, make good the light absorbed.

An extremely beautiful experiment of this kind was lately made here by Professor Liveing, with rays which, under ordinary circumstances, are entirely invisible. Professor Dewar and Professor Liveing have been long working with conspicuous success at the ultra-violet spectrum. Using prisms and lenses of a certain kind, and a powerful dynamo-machine to volatilize our metals, like Professor Liveing, I cast a spectrum upon the screen. Far beyond this terminal violet, waves impinge upon the screen which have no sensible effect upon the organ of vision; they constitute what we call the ultra-violet spectrum. Professor Stokes has taught us how to render this invisible spectrum visible, and it is by a skillful application of Stokes's discovery that Liveing and Dewar bring the hidden spectrum out with wondrous strength and beauty.

A small second screen is at hand, which can be moved into the ultra-violet region. Felt by the fingers, the surface of this screen resembles sand-paper, being covered with powdered uranium glass, a highly fluorescent body. Pushing the movable screen toward the visible spectrum, at a distance of three or four feet beyond the violet, where only darkness existed before, light begins to appear. On pushing in the screen, the whole ultra-violet spectrum falls upon it, and is rendered visible from beginning to end. The spectrum is not continuous, but composed for the most part of luminous bands derived from the white-hot crucible in which the metals are to be converted into vapor. I beg of you to direct your attention to one of these bands in particular. Here it is, of fair luminous intensity. My object now is to show you, with Professor Dewar's aid, the reversal, as it is called, of that band, which belongs to the vapor of magnesium, exactly as a moment ago you were shown the reversal of the sodium band. An assistant will throw a bit of magnesium into the crucible, and you are to observe what first takes place. The action is rapid, so that you will have to fix your eyes upon this particular strip of light. On throwing in the magnesium, the luminous band belonging to its vapor is cut away, and you have, for a second or so, a dark band in its place.

I repeat the experiment three or four times in succession, with the same unfailing result. Here, as in the case of the sodium, the magnesium surrounded itself for a moment by a cool envelope of its own vapor, which cut off the radiation from within, and thus produced the darkness.

And now let us pass on to an apparently different, but to a really similar result. Here is a feebly luminous flame, which you know to be that of hydrogen, the product of combustion being water-vapor. Here is another flame of a rich blue color, which the chemists present know to be the flame of carbonic oxide, the product of combustion being carbonic acid. Let the hydrogen-flame radiate through a column of ordinary carbonic acid—the gas proves highly transparent to the radiation. Send the rays from the carbonic-oxide flame through the same column of carbonic acid—the gas proves powerfully opaque. Why is this? Simply because the radiant, in the case of the carbonic-oxide flame, is hot carbonic acid, the rays from which are quenched by the cold carbonic-acid gas, exactly as the rays from the intensely heated sodium-vapor were quenched a moment ago by the cooler envelope which surrounded it. Bear in mind the case is always one of synchronism. It is because the atoms of the cold acid vibrate with the same frequency as the atoms of the hot that the pulses sent forth from the latter are absorbed.

Newton, though probably not with our present precision, had formed a conception similar to that of molecules and their constituent atoms. The former he called corpuscles, which, as Sir John Herschel says, he regarded "as divisible groups of atoms of yet more delicate kind." The molecules he thought might be seen if microscopes could be caused to magnify three or four thousand times. But, with regard to the atoms, he made the remark already alluded to: "It seems impossible to see the more secret and nobler works of Nature within the corpuscles, by reason of their transparency."

I have now to ask your attention to an illustration intended to show how radiant heat may be made to play to the mind's eye the part of the microscope, in revealing to us something of the more secret and noble works of atomic Nature. Chemists are ever on the alert to notice analogies and resemblances in the atomic structures of different bodies. They long ago pointed out that a resemblance exists between that evil-smelling liquid, bisulphide of carbon, and carbonic acid. In the latter substance we have one atom of carbon united to two of oxygen, while in the former we have one atom of carbon united to two of sulphur. Attempts have been made to push the analogy still further by the discovery of a compound of carbon and sulphur which should be analogous to carbonic oxide, where the proportions, instead of one to two, are one to one, but hitherto, I believe, without success. Let us now see whether a little physical light can not reveal an analogy between carbonic acid and bisulphide of carbon more occult

than any hitherto pointed out. For all ordinary sources of radiant heat the bisulphide, both in the liquid and vaporous form, is the most transparent, or diathermanous, of bodies. It transmits, for example, ninety per cent of the radiation from our hydrogen-flame, ten per cent only being absorbed. But when we make the carbonic-oxide flame our source of rays, the bisulphide shows itself to be a body of extreme opacity. The transmissive power falls from ninety to about twenty-five per cent, seventy-five per cent of the radiation being absorbed. To the radiation from the carbonic-oxide flame the bisulphide behaves like the carbonic acid. In other words, the group of atoms constituting the molecule of the bisulphide vibrate in the same periods as those of the atoms which constitute the molecule of the carbonic acid. And thus we have established a new, subtile, but most certain resemblance between these two substances. The time may come when chemists will make more use than they have hitherto done of radiant heat as an explorer of molecular condition.

The conception of these quivering atoms is a theoretic conception, but it is one which gives us a powerful grasp of the facts, and enables us to realize mentally the mechanism on which radiation and absorption depend. We will now turn to a more practical view of the subject. It is pretty well known that for a long series of years I conducted an amicable controversy with one of the most eminent experimenters of our time, as regards the action of the earth's atmosphere on solar and terrestrial radiation. My contention was that the great body of our atmosphere—its oxygen and nitrogen—had but little effect upon either the rays of the sun coming to us, or the rays of the earth darting away from us into space; but that mixed with the body of our air there was an attenuated and apparently trivial constituent which exercised a most momentous influence. That body, as many of you know, is aqueous vapor, the amount of which does not exceed one per cent of the whole atmosphere. Minute, however, as its quantity is, the life of our planet depends upon this vapor. Without it, in the first place, the clouds could drop no fatness. In this sense the necessity for its presence is obvious to all. But it acts in another sense as a preserver. Without it as a covering, the earth would soon be reduced to the frigidity of death. Observers were, and are, slow to take in this fact, which nevertheless is a fact, however improbable it may at first sight appear. The action of aqueous vapor upon radiant heat has been established by irrefragable experiments in the laboratory; and these experiments, though not unopposed, have been substantiated by some of the most accomplished meteorologists of our day.

I wished much to instruct myself a little by actual observation on this subject, under the open sky, and my first object was, to catch, if possible, states of the weather which would enable me to bring my views to a practical test. About a year ago, a little iron hut, embrac-

ing a single room, was erected for my benefit npon the wild moorland of Hind Head. From the plateau on which the hut stands there is a free outlook in all directions. Here, amid the heather, I had two stout poles fixed firmly in the ground eight feet asunder, and a stout cord stretched from one to the other. From the center of this cord a thermometer is suspended with its bulb four feet above the ground. On the ground is placed a pad of cotton-wool, and on this cotton-wool a second thermometer, the object of the arrangement being to determine the difference of temperature between the two thermometers, which are only four feet vertically apart.

Permit me at the outset to deal with the subject in a perfectly elementary way. In comparison with the cold of space, the earth must be regarded as a hot body, sending its rays, should nothing intercept them, across the atmosphere into space. The cotton-wool is chosen because it is a powerful, though not the most powerful, radiator. It pours its heat freely into the atmosphere, and by reason of its flocculence, which renders it a non-conductor, it is unable to derive from the earth heat which might atone for its loss. Imagine the cotton-wool thus self-chilled. The air in immediate contact with it shares its chill, and the thermometer lying upon it partakes of the refrigeration. In calm weather the chilled air, because of its greater density, remains close to the earth's surface, and in this way we sometimes obtain upon that surface a temperature considerably lower than that of the air a few feet above it. The experiments of Wilson, Six, and Wells have made us familiar with this result. On the other hand, the earth's surface during the day receives from the sun more heat than it loses by its own radiation, so that, when the sun is active, the temperature of the surface exceeds that of the air.

These points will be best illustrated by describing the course of temperature for a day, beginning at sunrise and ending at 10.20 P. M. on the 4th of last March. The observations are recorded in the annexed table, at the head of which are named the place of observation, its elevation above the sea, and the state of the weather. The first column in the table contains the times at which the two thermometers were read. The column under "Air" gives the temperatures of the air, the column under "Wool" gives the temperatures of the wool, while the fourth column gives the differences between the two temperatures. It is seen at a glance that, from sunrise to 9.20 A. M., the cotton-wool is colder than the air; at 9.30 the temperatures are alike. This is the hour of "intersection," which is immediately followed by "inversion." Throughout the day, and up to 4 P. M., the wool is warmer than the air. At 4.5 P. M. the temperatures are again alike; while from that point downward the loss by terrestrial radiation is in excess of the gain derived from all other sources, the refrigeration reaching a maximum at 7.30 P. M., when the difference between the two thermometers amounted to 10° Fahr. When the observations are

continued throughout the night, the greater cold of the surface is found to be maintained until sunrise, and for some hours beyond it. Had the air been perfectly still during the observations, the nocturnal chilling of the surface would have been in this case greater: for you can readily understand that even a light wind sweeping over the surface, and mixing the chilled with the warmer air, must seriously interfere with its refrigeration.

*Hind Head, elevation 850 feet; sky cloudless; hoar-frost; wind light, from northeast. Course of temperature, March 4, 1883.*

| TIME. | Air. | Wool. | Difference. |
|---|---|---|---|
| | Degrees. | Degrees. | Degrees. |
| 6.50 A. M. (sunrise) | 31 | 25 | 6 |
| 7.20 | 32½ | 24½ | 8 |
| 7.40 | 34 | 25 | 9 |
| 8.5 | 35 | 27 | 8 |
| 8.20 | 35 | 30 | 5 |
| 9.15 | 40 | 38 | 2 |
| 9.20 | 41 | 40 | 1 |
| 9.30 (intersection) | 41 | 41 | 0 |
| 9.40 (inversion) | 41 | 42 | 1 |
| 10.15 | 42½ | 45 | 2½ |
| 11. | 45 | 52 | 7 |
| 11.30 | 47 | 55 | 8 |
| 12 noon | 50 | 58 | 8 |
| 12.30 P. M. | 50 | 59½ | 9½ |
| 1. | 50 | 57½ | 7½ |
| 2. | 49 | 60 | 1 |
| 2.30 | 48 | 58 | 10 |
| 3. | 49 | 56 | 17 |
| 3.30 | 48 | 52 | 4 |
| 4. | 47 | 48 | 1 |
| 4.5 (intersection) | 47 | 47 | 0 |
| 4.10 (inversion) | 47 | 45 | 2 |
| 4.15 | 47 | 43 | 4 |
| 4.30 | 46 | 41 | 5 |
| 7. | 35 | 26 | 9 |
| 7.30 | 35 | 25 | 10 |
| 8.30 | 34 | 24½ | 9 |
| 9.40 | 33 | 24½ | 8½ |
| 10.20 | 32 | 24 | 8 |

Glacial wind from northeast. Stars very bright.

Various circumstances may contribute to lessen, or even abolish, the difference between the two thermometers. Haze, fog, cloud, rain, snow, are all known to be influential. These are visible impediments to the outflow of heat from the earth; but we have now to deal with the powerful obstacle to that outflow to which reference has been already made, and which is entirely invisible. The pure vapor of water, for example, is a gas as invisible as the air itself. It is everywhere diffused through the air; but, unlike the oxygen and nitrogen of the atmosphere, it is not constant in quantity. We have now to examine whether meteorological observations do not clearly indicate its influence on terrestrial radiation:

*January 16th.—Extremely serene; air almost a dead calm; sky without a cloud; light southwesterly air.*

| TIME. | Air. | Wool. | Difference. |
|---|---|---|---|
| P. M. | Degrees. | Degrees. | Degrees. |
| 3.40 | 43 | 37 | 6 |
| 3.50 | 42 | 35 | 7 |
| 4. | 41 | 35 | 6 |
| 4.15 | 40 | 34 | 6 |
| 4.30 | 38 | 32 | 6 |
| 5. | 37 | 28 | 9 |
| 5.30 | 37 | 30 | 7 |
| 6. | 36 | 32 | 4 |
| 6.30 | 36 | 31 | 5 |
| 7. | 36 | 28 | 8 |
| 7.30 | 35½ | 28 | 7½ |
| 8. | 35 | 26 | 9 |
| 8.30 | 34 | 25 | 9 |
| 9. | 35 | 27 | 8 |
| 10. | 35 | 28 | 7 |
| 10.30 | 35 | 29 | 6 |

With a view to this examination, I will choose a series of observations made during the afternoon and evening of a day of extraordinary calmness and serenity. The visible condition of the atmosphere at the time was that which has hitherto been considered most favorable to the outflow of terrestrial heat, and therefore best calculated to establish a large difference between the air and wool-thermometers. The 16th of last January was a day of this kind, when the observations recorded in the annexed table were made.

During these observations there was no visible impediment to terrestrial radiation. The sky was extremely pure; the moon was shining; Orion, the Pleiades, Charles's Wain, including the small companion star at the bend of the shaft, the North Star, and numbers of others, were clearly visible. After the last observations, my note-book contains the remark: "Atmosphere exquisitely clear; from zenith to horizon cloudless all around."

A moment's attention bestowed on the column of differences in the foregoing table will repay us. Why should the difference at 6 P. M. be fully 5° less than at 5 P. M.; and again 5° less than at 8 and at 8.30 respectively? There was absolutely nothing in the aspect of the atmosphere to account for the approach of the two thermometers at six o'clock—nothing to account for their preceding and subsequent divergence from each other. Anomalies of this kind have been observed by the hundred, but they have never been accounted for, and they did not admit of explanation until it had been proved that the intrusion of a perfectly invisible vapor was competent to check the radiation, while its passing away reopened a doorway into space.

It is well to bear in mind that the difference between the two thermometers on the evening here referred to varied from 4° to 9°, the latter being the maximum.

Such observations might be multiplied, but, with a view to saving space, I will limit the record. On the evening of January 30th the atmosphere was very serene; there was no moon, but the firmament was powdered with stars. At 7.15 P. M. the difference between the two thermometers was 6°; while at 9.30 P. M. it was 4°, the wool-thermometer being in both cases the colder of the two. On February 3d, observations were made under similar conditions of weather, and with a similar result. At 7.15 P. M. the difference between the thermometers was 6°; while at 8.25 P. M. it was 4°. On both these evenings the sky was cloudless, the stars were bright, while the movement of the air was light, from the southwest.

In all these cases the air passing over the plateau of Hind Head had previously grazed the comparatively warm surface of the Atlantic Ocean, where it had charged itself with aqueous vapor to a degree corresponding to its temperature. Let us contrast its action with that of air coming to Hind Head from a quarter less competent to charge it with aqueous vapor. We were visited by such air on the 10th of last December, when the movement of the wind was light from the northeast, the temperature at the time being very low, and hence calculated to lessen the quantity of atmospheric vapor. Snow a foot deep covered the heather. At 8.5 A. M. the two thermometers were taken from the hut, having a common temperature of 35°. The one was rapidly suspended in the air, and the other laid upon the wool. I was not prepared for the result. A single minute's exposure sufficed to establish a difference of 5° between the thermometers; an exposure of five minutes produced a difference of 13°; while after ten minutes' exposure the difference was found to be no less than 17°. Here follow some of the observations:

*December 10th.—Deep snow; low temperature; sky clear; light northeasterly air.*

| TIME. | Air. | Wool. | Difference |
|---|---|---|---|
| A. M. | Degrees. | Degrees. | Degrees. |
| 8.10 | 29 | 16 | 13 |
| 8.15 | 29 | 12 | 17 |
| 8.20 | 27 | 12 | 15 |
| 8.30 | 26 | 11 | 15 |
| 8.40 | 26 | 10 | 16 |
| 8.45 | 27 | 11 | 16 |
| 8.50 | 29 | 11 | 18 |

During these observations, a dense bank of cloud on the opposite ridge of Blackdown virtually retarded the rising of the sun. It had, however, cleared the bank during the last two observations, and, touching the air-thermometer with its warmth, raised the temperature from 26° to 27° and 29°. The very large difference of 18° is in part to be ascribed to this raising of the temperature of the air-thermometer. I will limit myself to citing one other case of a similar kind. On the evening of the 31st of March, though the surface temperature was

far below the dew-point, very little dew was deposited. The air was obviously a dry air. The sky was perfectly cloudless, while the barely perceptible movement of the air was from the northeast. At 10 P. M. the temperature of the air-thermometer was 37°, that of the wool-thermometer being 20°, a refrigeration of 17° being, therefore, observed on this occasion.

From the behavior of a smooth ball when urged in succession over short grass, over a gravel-walk, over a boarded floor, and over ice, it has been inferred that, were friction entirely withdrawn, we should have no retardation. In a similar way, when, under atmospheric conditions visibly the same, we observe that the refrigeration of the earth's surface at night markedly increases with the dryness of the atmosphere, we may infer what would occur if the invisible atmospheric vapor were entirely withdrawn. I am far from saying that the body of the atmosphere exerts no action whatever upon the waves of terrestrial heat; but only that its action is so small that, when due precautions are taken to have the air pure and dry, laboratory experiments fail to reveal any action. Without its vaporous screen, our solid earth would practically be in the presence of stellar space; and with that space, so long as a difference existed between them, the earth would continue to exchange temperatures. The final result of such a process may be surmised. If carried far enough, it would infallibly extinguish the life of our planet.—*Contemporary Review.*

## THE LITTLE MISSOURI BAD LANDS.

By Professor T. H. McBRIDE.

### I.

"All things are engaged in writing their history. The planet, the pebble goes attended by its shadow. The rolling stone leaves its scratches on the mountain; the river its channel in the soil. . . . The falling drop makes its sculpture in the sand or stone."—Emerson.

BAD Lands, so called, occur in various parts of the wide plateaus adjacent to the Rocky Mountains. There are Bad Lands in Kansas, Bad Lands in Nebraska, in Dakota, and in the Territories farther west. The English name, probably because of intelligibility and brevity, seems about to supplant the old French *Mauvaises Terres* by which early travelers were wont to describe these remarkable regions. Either appellation is appropriate, for these lands, at ordinary estimate, are in many places nearly valueless, and yet the *voyageur* meant by his *mauvaises* probably nothing more than that the country was difficult of transit—*terres mauvaises à traverser.* However this may be,

it is certain that these regions are full of interest and attraction for the traveler, the student, and the naturalist.

Although Bad Lands are everywhere much the same thing, and a discussion of one locality might seem applicable to all, yet there are differences—due, no doubt, to varying conditions in times long gone by. It is not intended here to discuss these differences, but to speak briefly of what may be seen in the valley of the Little Missouri River, in Northwestern Dakota.

This little stream, by courtesy a river, rolling its murky waters northward and eastward for a distance of about two hundred miles, near the line separating the Territories of Montana and Dakota, is bordered by landscapes which in detail are without parallel, and in general effect transcend the possibilities of description. As the visitor approaches from the east, there arises suddenly before him from the monotonous plain a wondrous array of myriads of hills and hillocks —hills of nearly uniform height, but of every conceivable shape and form. Some are almost rectangular, with precipitous sides; many are conical; many are dome-shaped; some have the form of a frustum of a cone, and, on the summits of some, perfectly conical heaps appear. The greater number are flat-topped, and, rising to about the same level, give the impression of some splendid rampart extending for miles and miles along the horizon; some slope up gently from a narrow valley for seventy-five or a hundred feet, and end in a lofty rotund tower of naked sandstone. To all this diversity of form there is added diversity of color. The sides of all these mounds are almost verdureless, so that the absence of green is conspicuous, but almost every other hue is represented. Colors occur in broad bands across the faces of the hills—red and gray and yellow and black, purplish-blue and ashy and pink—in an unending series of shades and tints. Nothing is brilliant, but everything soft and beautiful. Here and there, from a broader base, a hill towers away above all its surroundings, and becomes a landmark visible from afar. In the parlance of the West such a landmark is called a *butte*,* and, if one has strength and patience to climb the summit of a butte, surely his reward is great. From no other *point d'avantage* on this continent does a man open his eyes upon a panorama wilder or more weird. In one direction a thousand motley heaps cover the plain like the tents of some wide-spread army; in another, the flat-topped mounds stretch away to meet the horizon, and seem like the steps of some Giant's Causeway leading to the sky; while, as evening comes on and the sun goes down, the play of colors, the shifting light and shadow present a scene in presence of which the most prosaic must for the nonce feel the inspiration of the poet.

But, if this weird region is thus interesting to the ordinary tourist, much more so is it to the student—to him who seeks to know the how,

* This term is also applied to a high hill of any sort, even to a mountain-peak.

if not the why, of all things terrestrial. Here is a corner of the world in which the evidences of change—of transition—are so patent that a glance reveals them to the dullest beholder. It is as if Nature were here trying to impress upon her children a great object-lesson, as if the universal Dame had said: "Behold! Look! Here have I stripped all the hills and laid bare all the valleys, that you might learn my time-honored methods, and once for all see something of how worlds are made." No man would say, as he looks for the first time out over these naked hills: "Such have they ever been; such shall they always be." By no means. These, at least, are not the "everlasting hills." Here is transition. Now, transition is to the student a word of magic sound—echoing the past, prefiguring the future. Let him but behold any of Nature's processes in intermediate stage, and mystery as to mode and method vanishes; the solution is easy.

But, now that our object-lesson is before us, what can we learn about it? Let us look again from the top of the butte, this time for instruction rather than for pleasure. See, there the river winds—a silver thread, shut in by long lines of banded bluffs. Into the river-valley principal ravines debouch, others into these, and so on to the very base of the bluff on which we stand. And now, you say, the problem is solved; the river is the outlet, and all these strange phenomena are due to surface-drainage. Here is the water-system, and here are its effects. But this answer can be but part of the truth, else why are no Bad Lands seen along the Desmoines or the Tennessee? Why are they not of universal occurrence? Besides, the beds of all these ravines are, for the most part, flat and level as a floor, scantily covered with short grass, or white with sage-brush (*Artemisia*). Only here and there a gully without water, or perchance, in some larger ravine, we may find a tiny, scarcely flowing streamlet, brown with alkali. Manifestly the river-system accounts for the general features of the country, but not for that which is peculiar. But let us look at the problem in another way. Let us begin at the bottom of these hillocks, at least as low down as we may come, and study for a moment the hillocks themselves.

We have already incidentally noticed the uniform stratification which characterizes the whole country, and is revealed by the banded appearance of the hills. At the base of one of these hills we may find (Fig. 1) a stratum of pale, yellowish clay. Just above, and perfectly conformable, is a layer of lignitic coal, inferior to soft coal, of a deep-brown color, rapidly crumbling on exposure to the air, and even, when in sufficient mass, liable to spontaneous ignition. Overlying the coal is another bed of clay of an ashy hue, containing more or less sand in composition. Next comes a layer in which sand predominates, a distinct gray in color; then a bed of clay of a bluish tint, another layer of coal, a layer of yellow clay, a stratum of very soft sandstone, another bed of clay, and then a foot or two of reddish-

brown sandstone, very unequally hardened and mixed with clay. Surmounting the whole is a bed of soft clay of varying thickness, mostly a sort of remnant, persisting only in mounds and the conical heaps already referred to.

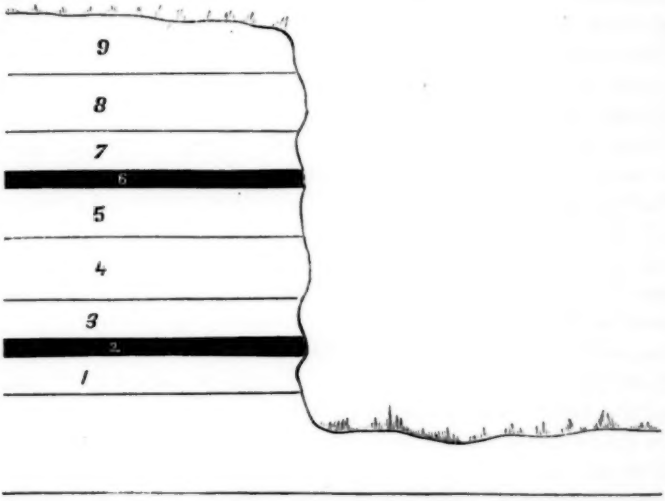



FIG. 1.—DIAGRAMMATIC SECTION OF A SINGLE BUTTE.

Now, all these strata, except the uppermost sandstone, have this common characteristic: they are composed of particles excessively fine, so that, if from any of the beds a little bit be taken, it may, when dry, be reduced between the fingers to an impalpable powder as fine as ashes. Even the lignite is no exception. If, now, in connection with this fact, and remembering the arrangement of the strata, we take into account the arid climate which prevails in all these regions, we are in position to understand much of the peculiar conformation of the Bad Lands. In the winter the snows are light, and in summer the rain that falls comes in sudden, violent, but short-lived storms. For perhaps half an hour after one of these storms, torrents flood the valleys and low plains between the hills, the rushing waters heavily charged with particles of clay, but particles so fine that they do not readily leave the water or become precipitated, but are borne on to the river, thence to the Missouri proper, which latter stream parts with them only as it blends in the clearer waters of the Mississippi. If, after the storm, we examine again the face of the bluff, we find it striated with numberless tiny channels, down which have just poured little rivulets of water hardly so much as wetting the surface, while from top to bottom the erosion has been about the same, the slightly increased density of the upper layer enabling them to sustain the brunt of the storm, and yet suffer no more wear than the softer strata beneath.

It is manifest that if this process be continued, and if all the hills are like that described, the reduction of all these terraces and mounds is but a question of time, and we may look forward to the day when all this now wild and impassable country shall be but a prairie of gentle undulations and monotonous outlook, not dissimilar to the wide plains which even now stretch off far to the east to blend with the Missouri Valley. Every mountain shall be made low and every valley filled, and no force more violent be concerned than the gentle action of the wind and rain.

I have said that the *detritus* of the storm is non-precipitate, is borne away by the water; and yet some of the moving particles do find lodgment by the way. There is no such thing as a talus at the foot of the bluff, but after each flood a thin film of fine silt is spread over the plain, and the flat bottoms of the ravines are by imperceptible pace forever creeping up the wasting buttes, particularly of those remote from the river.

But such a butte as that described, while revealing much, does not reveal all the facts necessary to the full understanding of our subject. One of the first things to strike the attention of the tourist among the hills is the evidence of the wide-spread action of powerful heat. The bands of red which everywhere mark the landscape are certainly traces of some glowing fire. But what a fire! Here are whole beds of clay baked until they have taken on the color and character of hard-burned brick or unglazed pottery. The resonance of the dry fragments under the hammer or the wheels of our vehicle is precisely that of broken terra-cotta. Sometimes the top of the butte is bare and red; sometimes the whole mass, from top to bottom, has been burned, and at a distance seems like a brick-kiln fallen into ruin. The splintery fragments, broken as macadamizing stone, form over the entire surface a natural riprap, on which the elements spend their force in vain. Such buttes are not transient; the fire has saved them, and in this dry climate they may stand forever. Here and there, so hot has been the fire, that the clay has been not only baked but fused, and great clinker-like masses rest upon the hill-top, thrust themselves out from the hill-side, or stand naked like monuments on the plain.

In looking for the source of heat capable of producing such phenomena men seem instinctively to revert to volcanic fires, and the burned clay is everywhere designated scoria. In one place where the railroad cuts through a hill of this material we have "Scoria Cut," and scoria constitutes for miles the favorite ballast. But probably volcanic fires were never nearer than at present. Of crater, lava, trap, or other usual volcanic concomitants, there is not the remotest sign; but to-day, while we are theorizing over the matter, some of the furnaces which have baked all these regions are still glowing, the smoke yet ascends, and our own eyes may witness something of the transformation. The lignite-beds furnish the fuel, the slow-paced erosion lays the fuel bare,

spontaneous combustion supplies the torch, and the whole phenomenon is explained.

That the lignite is in some way connected with the fiery metamorphosis of the Bad Lands we might have inferred from the fact that no lignite ever appears above the burned belts, and in a hill entirely burned the lignite is entirely wanting. The burned clay also corresponds in position to beds overlying the coal in hills immediately adjacent. But, as we have said, the fires in isolated spots are still burning; in some places wholly subterranean, smoldering and smoking, at other points readily seen both in nature and effects. We may discover the coal on one side of a broad-topped hill, and on the other we may look from the hill's summit down through gaping rifts to the same horizon and see everything molten at white heat, while hot air, smoke, and coal-gas, as from a furnace, make the region almost inaccessible. The accompanying diagrams (Figs. 2, 3) illustrate a burning coal-bed, which has been photographed and dubbed "The Crater." Here the fire is burning out the lignite beneath a valley lying between two rounded ridges. As fast as the coal is removed by combustion the whole section of the valley sinks, creating with respect to the stratification what geologists term a *fault*. At the lowest part of the

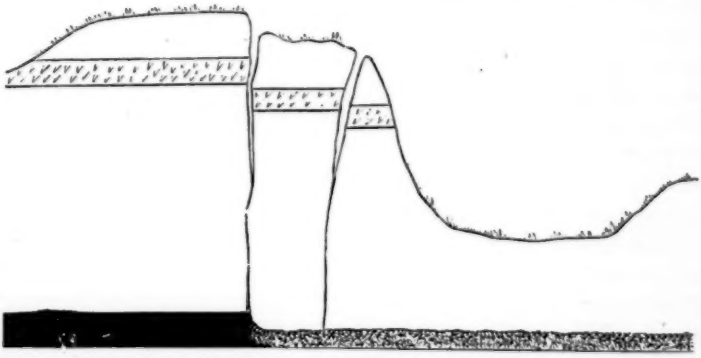


FIG. 2.—TRANSVERSE SECTION OF BURNING LIGNITE—THICKNESS OF LIGNITE-BED EXAGGERATED.

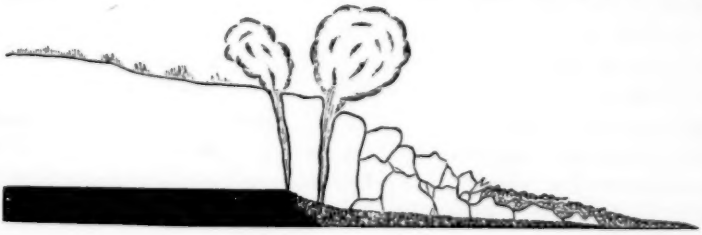


FIG. 3.—LONGITUDINAL SECTION OF BURNING LIGNITE—THICKNESS OF LIGNITE-BED EXAGGERATED.

valley, where the fire is nearest the surface, the entire superstratum breaks up and crumbles to ruin. When, after a summer storm, the flood comes down the valley, shoots into the crevices, and runs along the fissures, something like an explosion takes place. On every side volumes of steam ascend, but the fire is not extinguished. The loosened earth is much of it swept away, and a deep gulch forms between the ridges, and so the air comes freely to the fire, which might otherwise be smothered in its own ruin. Meanwhile the hearts of the hills themselves are baked like tiles in a close kiln, and while the fire would seem to hasten erosion, as in some places it certainly does, yet the metamorphism accomplished tends in the opposite direction, and is efficient in proportion to the completeness of the change.

And so the work goes on; one bed of lignite after another takes fire, one butte after another becomes the cover of a kiln, a furnace, and the whole country is transformed. I say the work goes on; better, *has* gone on, for it is nearly done. Glowing or smoldering through ages past, now hidden in darkness, now breaking forth to light, these secret fires have been burning, burning like a hidden fever, until the fair face of Nature has become an arid desert.

Thus the Bad Lands, as we know them, are the results of the action of two opposing elements, the water and the fire. Of these two the first had doubtless acted alone long before the second entered at all into the problem of disintegration. These level tops bespeak a former continuous level plain. More than this: into the highest of the buttes we may trace the same strata which make up the lower hills. The level must at one time have been higher still than we had first supposed. The changes of the past are enormous as compared with anything shown by the present, or even possible in the future of these strata. Owing to the peculiar nature of the strata, their uniformity and lack of solidity, the erosion has produced effects unique, and to these the fire has brought permanence and stability. Far as the coal-beds extend erosion has been or is liable to be arrested, and the country doomed to infertility. But the coal is not universally present. Many places are free from it entirely, and here erosion may continue unchecked its peaceful processes until all is beaten down to the common plain. In other places the coal takes fire in but isolated hills, and these become permanent while all else is reduced to prairie. And now we remember that away to the east the plains sometimes show a solitary hill, whose sides, reddening beneath the sparse grass, and whose summit, glowing in the sunshine, betray its origin.

# TECHNICAL EDUCATION.

By A. CURTIS BOND.

THE general increase in schools of design, technical schools, and like institutions, has created no little comment, and given rise, to some extent, to opposition.

It is a difficult matter to reconcile the differences between the opponents and those who favor this form of instruction, for the reason that the question, in a measure, is one of pecuniary interest to both parties.

There are many instances in which technical education may justly be claimed to be a necessity, and naturally, in those professions which demand a knowledge or a character of schooling, that can be more thoroughly conveyed by means of that which instructs in the *theories* of a craft or art, as distinct from its practice.

In the case of the architect, for example, nature may indicate the urgencies of the profession; it provides for the beautiful, for the attractive features, but the details it avoids; teachers must show the mechanical portions of the work, and instruct in the principles which make the building possible and form a support for the decorative exterior. The necessity of such teachings was recognized by early nations, and in their architecture and designing its value was taken into consideration, and its spirit must have existed among the early Aryans, as its materialized form did with the skilled and finished draughtsmen of Egypt and Greece.

We may easily realize the increased need of technical training today over the necessity of two thousand years ago. At that time, the artist himself did the work, the actual labor; he evolved the idea and executed it, the brain that conceived the thought guided the hand that gave that thought substance and shape. Every touch of the chisel imparted life, for the spirit of the worker went into the stone, and it was molded and shaped by the genius of the thinker. Now it is mechanical: the artist originates, others execute, and this execution must follow patterns, designs, plans. No scope is given the workman; he is bound by lines beyond which he dare not go, and his fancy, if he has any, serves naught in the creation of his subject; drawings control this creation, and the living translator of those drawings, from what was in the past an intelligent reasoner, has become in the present an automatic machine.

Disposing thus of a man's individuality, some means are essential to convey the thought of the designer into the hand of the worker, and customs have grown and laws have been adopted that will serve as a sort of mental telegraph between these two—laws which govern the flight of the artist's fancy and instruct the artisan in an under-

standing of the designer's purposes. Taking this view of the situation, it is certainly necessary that talent should be technically tempered.

It is not to be expected that every one learning a trade will become an expert or an innovator; ability to comprehend the requirements of trades are developed in either the shop or the school, but the regrets so often expressed by those who have grown up from apprentices for their lack of education evinces the limited possibilities of practical knowledge simply, and demonstrates, in a measure, the necessity for an early instruction in the theories, if one thinks to introduce improvements and progressions in his profession.

The want of education, with which most apprentices must contend, interferes in other ways with their progress. The master is apt, in many instances, to exaggerate the difficulties to be overcome, and enlarge upon the mysteries surrounding his work-bench. The doubt this would arouse in an unschooled mind might be fatal to success, and the superstition that there was something impossible for the apprentice to comprehend, is liable to remain with him as a drag-net to his future usefulness, trammel his ambition, and perhaps turn his abilities into a channel less profitable to himself and to the world.

Technical schools, adopting as they do a different course, impress the students with the comparative simplicity of business, and give them the feeling of ability to grasp and utilize the intricacies and peculiarities of the trades. That which is formidable to the uninstructed becomes a *bagatelle* to those familiar with the details and with those who have an intelligent theoretical acquaintance with the governing principles. It is true, this theoretical knowledge can not provide for all emergencies that are likely to occur in the workshops, but it lays a foundation which will aid the student, when those emergencies present themselves, in comprehending and overcoming the difficulty; and it is a question we would be loath to decide in the negative, whether or not a mechanic, who, after being educated in a technical school, had had a reasonable experience in a shop, would not find a readier and more effective remedy for an accident than one who had been brought up in a shop and lacked school training.

Another consideration worth noting is the comparatively short time during which a man improves his skill in the trade or art he may have adopted. The Technical Commission of Great Britain sets the period at from ten to fifteen years as a maximum, and this may be regarded as a reasonable estimate for the time at the end of which progress in the individual ceases; and, such being the case, it is proper to give at the outset all the helps toward developing talent that are attainable. Technical education may be one of these helps.

If it were possible to acquire theory and practice at one and the same time, its desirability would be indisputable, but, we imagine, this in its true sense is impracticable. The practice obtained in technical

schools is not the real, genuine, unadulterated article, and it would be a dishonest teacher who would put forth any such claim. It is impossible to foresee, as we have said, all the necessities that arise, and are likely to arise, in the course of business experience, and they absolutely require, when they obtrude upon the regular course, the judgment of a mind that has been accustomed to coping with difficult situations where a failure to devise a remedy at once meant an utter failure of the entire work.

But one of these qualifications must, in the order of things, precede the other, and we are confronted with the question, Which shall it be?

Theory—that is, the comprehension and understanding of whatsoever we undertake—is the foundation upon which practice may build; theory will necessarily acquire the mechanical ability to put its ideas into shape by a reasonable amount of practice; but practice, though it be of years, does not by any means guarantee theoretical or even an intellectual appreciation of the results that labor accomplishes, and without this what can be expected from the mechanic? We certainly should not ask for improvements from a man who does not understand the foundation principles of the mechanical part of his work. Starting with a fairly good technical or theoretical education, one grapples with the problems of business more intelligently and, in most cases, more successfully. If one chance to become an employer, he can utilize the practice of his employés to demonstrate his theories, and often will this theorizing, and the thoughts created by an early technical education, suggest means for lightening, simplifying, and improving the labor that practice had failed to find an opportunity of modifying.

## THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

### CLIMATIC FEVERS.

LIFE is a sun-child; and nearly all species of plants and animals attain the highest forms of their development in the neighborhood of the equator. Palm-trees are tropical grasses. The python-boa is a fully developed black-snake; the tiger an undiminished wild-cat. With every degree of a higher latitude, Nature issues the representatives of her arch-types in reduced editions—reduced in beauty and longevity, as well as in size and strength.

The human animal, however, seems to form an exception to that general rule. For the last two thousand years, nine out of ten international wars ended with the victory of northern nations over their southern neighbors. The hegemony of commerce and superior civili-

zation moves farther and farther north. Our oracles have been transferred from Delphi to Berlin, to Edinburgh and Boston. The Muses and Graces are wearing fur cloaks. Has the sun of the south lost its stimulating power? The truth seems to be, that *cold air is an antidote.* The antiseptic effect of a cold climate enables us to indulge with comparative impunity in numerous vices which our southern neighbors have paid with the loss of their moral and physical health. It has been ascertained that alcoholic stimulants, instead of increasing actually *decrease* the temperature of the system, and that cold weather constitutes no valid excuse for the use of intoxicating drinks, but it is equally certain that a low temperature promotes recovery from the effects of intoxication. Many hyperboreans eat flesh as a stimulant rather than as a medium of calefaction; tea-drinkers contract a morbid craving for boiling-hot beverages. But climatic influences increase the activity of their digestive organs to a degree that enables Nature to compromise the violation of her laws. Gluttons and topers die in the south and survive in the north, not because a warm climate *per se* is incompatible with the normal vigor of the human system, but because a cold winter counteracts the effects of gluttony and intemperance in much the same way as rum counteracts the effects of a snake-bite, or mercury the virus of the *lues veneris.* Frost is a counter-poison. Protracted impunity tempts sinners to believe in the innocence of their habits. During the two centuries when the Cæsars vied in the gratuitous purveyance of bread, oil, and circus-games, the Roman citizens had no special reason to admit the turpitude of idleness. Under the protection of the Holy Inquisition dunces were secure enough against the competition of genius to consider ignorance as a virtue. Thus the prophylactic influence of a frigid climate has made the propriety of many of our daily sins so axiomatic that the neglect of their practice excites a sort of virtuous indignation. A German proverb, traced to the table-talk of an eminent reformer, denounces the demerits of the man who fails to worship music, women, and—wine. To many minds closed bedroom-windows and three warm meals a day are essential conditions of true respectability. Even in the dog-days, the impropriety of Scotch knee-breeches would be thought worthy of a harsher name. When financial embarrassments obliged the later Cæsars to abolish the free-lunch system, the astonishment of the *cives Romanus* was only equaled by his wrath at the injustice of the innovation; and with a similar mixture of indignation and surprise thousands of exiles from the regions of prophylactic frost denounce the malignity of a climate that fails to protect them from the logical consequences of their sins against nature. In summer weeks, when the creoles pass the night on their flat house-roofs, with a mattress and a linen bed-sheet, and regret at the necessity of adding a mosquito-cap, the foreign resident insists on sleeping in a flannel undershirt, under woolen blankets, and the impression that his life depends on keeping

his doors and windows hermetically closed. During the noontide glare, when the youngsters of the native patricians run about in white muslin inexpressibles, and their plebeian comrades in a still less expressible and certainly unspeakably sensible costume, the children of the north have to mourn their exile in black broadcloth, woolen stockings, boots or air-tight gaiters, tight-fitting collars, neckties, and waistcoats, besides the unavoidable flannel undershirt. And, worse than that, the ex-hyperborean not only continues to gorge himself with an amount of calorific food that would more than suffice for the climatic exigencies of his own latitude, but persists in eating that excessive amount in the specially indigestible form of fried and broiled meat, served smoking hot with greasy sauces, after a prelude of sudorific doses of hot soups or narcotic drinks. In a cold climate the pathological results of overfeeding are chiefly limited to the evils of mal-nutrition, i. e., the difficulty of eliminating the cachectic elements of a mass of accumulated and fermenting ingesta. But in a warm climate that result is complicated by the further difficulty of maintaining the normal temperature of the system. For the organic functions of the animal body require a uniform degree of warmth as a condition of their healthy performance, and in the human body the normal average of that temperature has been found to be about 98° Fahr. A variation of only two degrees denotes an abnormal depression or acceleration of functional activity, a difference of five degrees indicates a serious disease. In the polar regions, where a rousing stove-fire often fails to thaw the rime-frost on the stove-pipe, the organism of the human body contrives to maintain its blood-heat within half a degree of the normal average, i. e., sometimes at a temperature of 150° above that of the external air. In the tropics the same marvelous organism becomes a refrigerating apparatus, and lowers its temperature as much as thirty degrees below that of the outer atmosphere, which in British India, for instance, has been seen at 132° above zero, or a hundred degrees above the freezing-point.

In these thermal regulations, Nature has, however, to rely on the co-operation of instinct or reason; and a mariner who would wear the same dress on a north-pole expedition and a trip to Suez could hardly hope to escape the consequences of his imprudence. But even if the Arctic explorer should not only forget his furs, but intentionally chill his blood by sitz-baths on an ice-floe, and promenades in the costume of the Nereids, his chances of continued health could hardly be worse than those of the British merchant who practices in the tropics the calorific artifices of his native land, and aggravates the blood-seething effects of a West Indian summer by superfluous clothes and worse than superfluous beefsteaks and sudorific drinks. The blood of the sitz-bathing mariner would congeal; the blood of the beef-eating merchant does *ferment*. With all diversity of opinion as to the proximate cause of climatic fevers, there is no doubt that the febrile blood-changes

indicate the agency of a catalytic, or fermentative process. In yellow fever the temperature of the body rises to 105°, and *after death* often to 112°; the progress of decomposition separates the serum from the red blood-globules (whence the chlorotic hue of the skin), and the bodies of the victims need immediate interment on account of the rapidity with which putrefaction begins, or rather completes, its work. The clinical study of the disease in such towns as Vera Cruz and New Orleans has preserved the record of many curious cases of molecular life after somatic death. Dr. Bennett Dowler ("New York Journal of Medicine," 1846) mentions the case of an Irishman whose arms, after the cessation of respiration, rose and fell with a rhythmical motion, and of a Kentuckian whose flexor muscles, four hours after death, reacted against the slightest mechanical stimulation. The symptoms of ordinary "chills and fevers" can be temporarily suppressed by antiseptic drugs—quinine, arsenic, strychnine, ferro-cyanide of iron—in fact, by all chemicals that would arrest a process of decomposition. Hence also the prophylactic effect of alcohol ("tonic bitters") and of Nature's great antiseptic, frost. That marsh-miasma is only an adjuvant cause of endemic fevers can be abundantly demonstrated by the comparative study of the typographical and climatic conditions of the chief fever-centers, as well as by many unmistakable analogies of "climatic fevers" and certain enteric diseases which can be traced to purely subjective causes. The swampiest districts of Central and South America—the Peninsula of Yucatan, Tehuantepec, the Brazilian province of Entre-Rios, the Orinoco Valley, the "Gran Chaco," or monster-swamp, between Bolivia and Paraguay—enjoy an almost perfect immunity from pyrexial diseases, while Vera Cruz and Pernambuco with their zone of barren sand-hills, or La Guayra, Havana, and Rio Janeiro, with their mountainous vicinity, are subject to yearly visits of the plague. During our last two epidemics the vast Arkansas river-swamps, and the coast-fens of Georgia, Florida, and Texas, escaped, while Vicksburg and Memphis, on their dry bluffs, and Chattanooga, at an elevation of six hundred feet above sea-level, suffered more in proportion to their populations than any place this side of Vera Cruz. During every fever-epidemic the focus of the disease seems to be some commercial city of the tropics or sub-tropics, a town uniting torrid summer climate with the presence of a large number of northern foreigners.

In all fevers ascribed to a malarial origin the success of the conventional mode of treatment depends chiefly upon the efficacy of chemical antiseptics which temporarily suppress or palliate the symptoms of the disease, but (aside from the deleterious after-effects of such drugs) the disease itself can be cured only by the removal of the cause. That cause is the inability of the vital powers to withstand the influence of moist heat from within and without. The proper method of cure, therefore, consists in diminishing the thermal prod-

uct of that complex cause, either by flight to a colder climate, or by adopting a less calorific regimen. The latter expedient is the cheaper, and generally the shorter and safer one; and in no other disease is the remedy more clearly indicated by the promptings of instinct. The premonitory stage of yellow fever is characterized by an intense longing for *refrigeration:* fresh air, cold water, cooling fruits or fruit-extracts. The fever-dreams of an ague-patient are crowded with visions of tree-shade and mountain-brooks. Even "chills" are often accompanied by a burning thirst; and during the cold stage of an intermittent fever the temperature of the system is actually higher than during the sweating stage; according to Dr. Francis Home, respectively 104° and 99°.

In the first place, remove the patient to the airiest available room in the house. The art of house-cooling seems to have been lost with the ancient civilization of Southern Europe. There is not a room in the narrowest alley of the Naples Jew quarter where open windows and ten cents' worth of ice would fail to lower the temperature from twenty to thirty degrees below that of the outer atmosphere. Create a draught, and if possible a cross-draught, without fear that the admission of air from a sun-blistered courtyard, for instance, would make the room equally uncomfortable; the thermal contrast itself will create an air-current, and that draught will be cooler to the feeling than stagnant air of an actually lower temperature. The shade of a leafy tree is never more grateful than when the surrounding fields tremble under the rays of a vertical sun. The evaporation of ice-water, or even of common cistern-water, will greatly aid the good work. Pour it into flat basins, tubs, etc., and place them in the center of the room, or get a wheelbarrow full of unglazed bricks, that can be procured at any pottery, put them close together on the floor and sprinkle them from time to time with cold water. The water will soak into the porous mass and evaporate more rapidly than from an impervious surface. A bundle of bathing-sponges or a sheaf of bulrushes, suspended from the ceiling and sprinkled from time to time, will serve the same purpose; and, where ice is cheap, a dog's-day sirocco can be easily reduced to an April breeze.

But the best time to begin the refrigeration-cure is an hour after sunset. On this continent alone, the *night-air superstition* costs annually the lives of about fifteen thousand human beings; for at least one half of the thirty thousand North Americans who succumb every year to yellow fever, ague, and congestive chills, could have saved themselves by opening their bedroom-windows. In the jungles of our Southern Gulf-coast thousands of hunters and lumbermen breathe with impunity the air of the very swamps to whose neighborhood the city-dweller ascribes the summer epidemics. Their febrifuge is the cooling night-wind, for here, as in the dyspeptic shopkeeper cities and consumptive factory-towns, each night labors to undo the mischief of each day.

The flat-boat men who often contract the ague during a week's delay in a Southern inland port, need no quinine by the time they reach New Orleans, a week or two of chill night-camps on the open river having cured them as effectually as the first November frosts cure the chlorotic city-dweller.

For direct refrigeration a *sponge-bath* is more effective as well as less disagreeable than a wet-pack; though an *air-bath*, before an open window (under cover of night) is preferable to both, if the strength of the patient is reduced by a protracted ague or injudicious medication. In obstinately sultry weather an *ice-pack* will afford almost immediate relief—a pailful of crushed ice, stuffed into linen bags and wrapped for a few minutes around the neck and arms, or around the wrists of a bedridden patient.

"Stuff a cold and starve a fever" was, in regard to fevers, at least, not a bad plan, when "stuffing" implied a monster dose of beef and beer. But the want of appetite which characterizes all febrile affections is properly defined as only an abhorrence of calorific food—flesh, hot soups, and greasy made-dishes. The mere sight of such comestibles is enough to aggravate the sick-headache that precedes yellow fever and follows an ague-fit, and, when the idea of food has become closely associated with visions of smoking grease, the voice of instinct is apt to be in favor of total abstinence. But that protest is always accompanied by a passionate craving for cooling drinks, which easily connives at an admixture of solid nourishment, after a refrigerating diet has once been tasted in the form of cooling fruits. Cold sweet milk, whipped eggs with a drop of lemon-flavor, a sherbet of ice-water, sugar, and orange-juice, offered to the rebellious stomach of a fever-patient, are not only tolerated, but absorbed with an almost conscious satisfaction. Fruits, however, rank first among the dietetic febrifuges of Nature, especially tropical fruits. "Under the exhaustion of a blazing sun," says Sir Emerson Tennent,* "no more exquisite physical enjoyment can be imagined than the chill and fragrant flesh of the pineapple, or the abundant juice of the mango, which, when freshly pulled, feels almost as cool as ice-water. . . . It would almost seem as if plants possessed a power of producing cold, analogous to that exhibited by animals in producing heat. Dr. Hooker, when in the valley of the Ganges, found the fresh, milky juice of the *mudar* (calotropis) to be but 72°, while the damp sand in the bed of the river where it grew was from 90° to 104°."

With a biscuit or two, a sliced pineapple, two or three bananas or a couple of oranges, will make a sufficient meal; and in very warm weather bananas alone would do for a couple of days, for the nutritive value of saccharine fruit is generally underestimated; our next relatives, whose digestive organs are a close copy of our own, are exclusively frugivorous, and withal the most active and indefatigable crea-

* "Ceylon," p. 121.

tures of their size. With cold, sweetened orangeade alone, the physicians of the Spanish-American hospitals often support their comatose patients for days together.

These remedies should be applied in the very beginning of the disease. As soon as the yawning and stretching languor of a bilious remittent announces the approach of an ague-fit, the patient should prepare for refrigeration by sponge-baths, air-baths, and rest, in a shady, well-ventilated room. The thirst that announces the needs of the internal organism should be freely indulged with fresh spring-water (or the next best thing, filtered and ice-cooled cistern-water). I would not prevent a fever-stricken child from drinking five quarts of water in as many half-hours, if its system craves it, for, besides its refrigerating influence, fresh water fulfills an important expurgative purpose, and helps to eliminate the catalytic germs of the tainted blood. During the shivering stage of a fever there would not seem to be much need of artificial refrigeration; but I have noticed that a fit of "chills" is far more supportable if the craving for a warm cover is justified by an external cause. In a sultry room a woolen blanket is apt to turn a shaking fit into the ugliest symptoms of the hot and headachy stage, while in a cold room the shivering patient (covered up, but with his head exposed to a cooling draught) soon finds relief in a quiet slumber. The ancient Romans cured their fever-patients in subterranean grottoes, and where the means of refrigeration are as cheap as in the New Orleans ice-factory I would keep the yellow-fever ward of a hospital at a maximum temperature of 55°, and at night, if possible, below 50°. Wet-packs and a frequent change of posture greatly alleviate the throbbing pains in the loins, where the pyrexial process of a yellow-fever paroxysm seems to center its activity. * These pains are often accompanied by a stupor-like oppression of the brain and are grievously aggravated by a stagnant atmosphere.

In the tent-camp of Medellin, to where the French authorities had removed the fever-stricken paupers of Vera Cruz, I noticed that comatose symptoms occurred only in a small minority of cases, while their worst forms were frequently observed in all the city hospitals, except the excellently ventilated infirmary of the Catholic orphan asylum. In common ague, fresh air alone, and without the aid of fruit and ice (which can not be readily procured in some inland districts of our Southern States) will modify the paroxysms sufficiently to reduce them to debilitating rather than distressing symptoms—tremors, followed by perspiration, and a cerebral excitation somewhat resembling the first effects of certain intoxicants.

During the hot stage of an intermittent, delirium can be obviated

* "It is curious that the maximum of the heat observed after death should have been in the thigh, and the minimum in the brain. Dr. Bennett Dowler, of New Orleans, ascertained it to be (ten minutes after death) 102 in the brain, 109 in the axilla, and 113 in the thigh" (Carpenter's "Physiology," p. 619).

by keeping the patient in a half-sitting posture, and cooling his temples from time to time with a wet towel, or, in extreme cases, with the above-mentioned ice-pack.* After a profuse perspiration the pulse will gradually become normal, and the feverish brain pass into a sort of twilight state between slumber and more or less fantastic day-dreams, but without obstreperous symptoms and without oppressive headaches.

All this, however, on condition that the bark of *Cinchona calisaya* is left severely alone. I have seen *quinine-drunk* patients break away from their nurses and rush out into the street like Indian amuck-runners, or sit moaning on their beds, freed from the febrile diathesis, but afflicted with ear-aches that pierce the head like twinges of neuralgia, and often impair the hearing for months together. Quinine sticks to the system like mercury, and I doubt if there is such a thing as perfect recovery from the effects of its protracted use. Strychnine, bitter-orange peel, valeriana, arsenic, and snake-root, are equally objectionable, and often produce after-effects that are ascribed to other causes, or to a lingering nervousness induced by the fever itself. Besides, the removal of the cause is the only radical fever-cure; chemical antiseptics merely palliate the symptoms, as a cloth mantle would smother a fire, till it gets strong enough to break out through cloth and all. Frost kills out flies where arsenic fails. By the refrigeration-cure the zymotic disease-germs are, as it were, *frozen out:* the blood-heat of the system is reduced below the temperature which is a condition of their development. The quinine-treatment is an attempt to *poison them.* For a time that attempt may prove successful, but the patient becomes a slave to his drug, and, till frost sets in, one of the most nauseous of all medicines has to be applied from week to week, and generally in increasing doses. But, if the febrile diathesis has been subdued by a refrigerating diet, the most ordinary precautions suffice to keep the disease in abeyance. The cause has been removed. I will venture the prediction that the zymotic agency of climatic fevers, as of tuberculosis, will be traced to the development of a living organism, and I suspect that Nature's effort to eliminate the tainted humors constitutes the critical symptoms of the affection, while the periodicity of the disease is due to the periodical redevelopment of the parasites from their ova or vital rudiments. In the vomit of cruor that precedes the crisis of yellow fever, the system seems to make an attempt to eradicate the evil by a direct extrusion of the tainted particles of the blood (the fibrine and red corpuscles), at the risk of exhausting the vital pabulum by the impoverishment of the humors. The success of that heroic remedy ends the trouble: yellow fever

* Six parts of sulphate of soda and four parts of hydrochloric acid make an effective freezing mixture. The first piece of ice thus obtained can be used with common salt to continue the freezing process, and, mixed in a tin cup, will reduce the temperature of water in a smaller cup, immersed in the mixture, by as much as thirty degrees.

hardly ever attacks the same person more than once. Ague, on the contrary, recurs with the return of every favorable opportunity ; nay, persons who have suffered most from remittent fevers are especially liable to relapses, and, if the disease is allowed to continue, its result is the same impoverishment of the blood (chlorosis and jaundice) which the paroxysm of yellow fever effects in a few hours. It is not safe to count upon an early frost, or immediate relief by a change of climate (in midsummer, especially, when the weather is often as warm at the borders of the Arctic Circle as fifty degrees farther south). And the persistent neglect of dietetic precautions under reliance on the prophylactic effect of a weekly dose of quinine would be strictly analogous to an attempt to legalize the sins of Don Juan by saturating the system with mercury.

In yellow fever large doses of quinine directly increase the chief danger of the disease by arresting the excretion of uric acid, which, passing into the circulation, has been recognized as a main cause of the convulsions and coma which so often inaugurate the hopeless stage of the deliquium.

During the delirious paroxysms of climatic fevers, ice-water may be administered like medicine, by spoonfuls, but *solid food should never be forced upon the patient.* When coolness, sweetness, and fruity flavors can not make a dish acceptable to the appetite, its obtrusion upon the stomach would do more harm than good, and it is a great mistake to suppose that even total abstinence could in such cases aggravate the danger of the disease. At San Nazaro, near Brescia, the Austrian hospital-town after the battle of Solferino, a wounded Hungarian sergeant, whose three tent-comrades had died of typhus syncopalis ("spotted fever"), cured himself of the same disease by an absolute fast of eight days, not including the two days of his transport from the battle-field, when he had taken a cup of coffee and a mouthful of bread. In malignant cases of yellow fever the revulsions of the bowels often invert the digestive process for days together ; chyle, as well as the nutritive elements of the blood, are forced back upon the stomach and disgorged in that eruption of *cruor* commonly called the "black-vomit" ; and the ingestion of food would, under such circumstances, only aggravate the gastric distress.

With the power of assimilation, the appetite for solid nourishment gradually returns ; but this re-establishment of the digestive process is greatly retarded by the obtrusion of a distasteful diet, especially animal food and all greasy made-dishes. The peculiar dietetic whims of fever-patients, their sudden cravings for a special kind of food, drink, or condiment, can with certain exceptions (or the revival of an alcohol passion) be indulged without danger, and generally indicate a favorable turn of the crisis. "*Ya se va á volver ; pide chilé*"—"He'll soon be all right ; he's asking for chilé" (red pepper or pepper-sauce) —is a standing form of congratulation among the Spanish-American

friends of a yellow-fever convalescent. But even with chilé they would hesitate to tempt him with *garbanzas* or *guisado*, well knowing that the mere smell of greasy viands is often enough to bring on a relapse of the vomit. Disagreeable smells of any kind are, in fact, a potent adjuvant, if not independent cause, of a febrile diathesis. "A manufacture of artificial manure," says Professor Grainger, "formerly existedimm ediately opposite Christchurch workhouse, Spitalfields, which building was occupied by about four hundred children with a few adult paupers. Whenever the works were actively carried on, particularly when the wind blew in the direction of the house, there were produced numerous cases of fever, of an intractable and typhoid form. . . . The proprietor at last was compelled to close his establishment, and the children returned to their ordinary health. Five months afterward, the works were recommenced; in a day or two subsequently, the wind blowing from the manufactory, a most powerful stench pervaded the building. In the night following forty-five of the boys, whose dormitories faced the manufactory, were again seized with severe diarrhœa, while the girls, whose dormitories were in a more distant part, and faced in another direction, escaped. The manufactory having been again suppressed, there was no subsequent return of the diarrhœa" ("Report on the Hygienic Condition of the Metropolis," p. 36).

The Turkish custom-house officers fumigate their quarantine-buildings with a powerful but agreeably aromatic kind of incense-powder, which seems to serve all the purposes of disinfection, and could in many cases be substituted for the carbolic-acid libations that fill our hospitals with their scandalous odors. To the stomach of a fever-patient, however, the smell of boiling fat is still more offensive, and kitchen-fumes should be carefully excluded from the sick-room.

If these precautions are adopted in time, a common remittent generally terminates with the third fit, and yellow fever takes the form of a "walking case," as the Memphis physicians call that mild type of the disease which limits its symptoms to a few shivering fits, and a night's headache, and seems, in fact, to be nothing but a modified sort of a summer ague. Every pyrexial affection is essentially an enteric disorder, a bowel-complaint, and dietetic management alone will generally insure a favorable issue of the disease. The Spanish cigar-peddlers and Spanish and Italian fruit-venders of New Orleans inhabit the vilest alleys of the "French quarter," but their frugality has saved them again and again, when their flesh-eating neighbors died by hundreds. I have known vegetarians to survive in tenements where the rooms above, below, and around them were filled with fever-stricken families—decimated from week to week, dreading removal to the hospital like a sentence of death, but sticking to their flesh-pots and alcoholic "tonics." How *fruit*, the chief febrifuge of nature, came ever to be suspected of being the *cause* of pyrexial disorders,

would be utterly inexplicable without the analogies of the *post hoc ergo propter hoc* fallacy—our liability to mistake a coincidence for a causal connection. In cold weather the hyperborean biped retreats to his unventilated den and contracts a catarrh, which he ascribes, not to its true cause, foul air, but to *cold* air, having noticed that winter and pulmonary affections are annual concomitants. Fruits, like countless other products of nature, are most abundant when they are most needed, and have for ages *preserved* the health of our tropical ancestors; but their carnivorous descendant ascribes his affliction, not to his daily beefsteaks, but to the occasional peaches and watermelons of which he happened to partake about the *time* the fever took hold of him. At the end of the year, when fruits become scarce, fevers too disappear, and the proof seems complete. Inductive logic: but the precipitate follower of Viscount Verulam fails to explain the fact that in the swampiest and hottest districts of the Eastern Continent fevers and fruits exclude each other like science and superstition, and the still stranger fact that hundreds of Northlanders who scrupulously abstain from fruit are nevertheless victimized whenever they brave the sun of the lower latitudes. In cholera the fruit-delusion may have derived a color of plausibility from the circumstance that persons who have for months subsisted upon beef and farinaceous food are liable to an attack of diarrhœa after their first experiments with a more digestible diet. For analogous reasons a long incarceration makes a prisoner unable to bear the fresh air and clear light of the outer world. The creoles use pepper enough with their meat to dispense with other antiseptics, and yet eat fruit with every meal as the French serve a dessert of cakes and raisins—"*pour la bonne bouche.*" A dime's worth per day for every man, woman, and child, of such fruits as oranges, melons, or "Chickasaw plums," that can be bought in almost every Southern town, would soon ruin the business of the quinine-manufacturers and reduce the trade of the "bitters" distillers to customers who like to drink whisky under some more respectable name.

The Spaniards divide all articles of diet into *comidas frias* and *comidas calientes;* but their definition of calorific food does not quite coincide with Liebig's theory.* According to the nitrogenous and non-nitrogenous system, starch, sugar, gums, are "respiratory" food, and as exclusively heat-making as fat, while the experience-taught South American would unhesitatingly class starchy potatoes and starchy corn-bread with the *comidas frias*, the "cooling comestibles"; and flesh, eggs, and rich cheese with the heat-producers. Cold milk would be assigned to the former class, and, together with unleavened and

* Professor Draper ("Human Physiology," p. 27) warns us that Liebig's classification has been only "adopted for the sake of convenience," having no natural foundation. Funke, in his "Lehrbuch der Physiologie," p. 186, accepts it with considerable reservations. Verdeil, Robin, Mulder, and Moleschott, reject it as wholly untenable.

"unshortened" bread, fruit, or fruit-jelly, constitute the dietetic specifics for convalescents from climatic fevers. Subacid fruits are, on the whole, more cooling than purely saccharine ones (figs, for instance); but *bananas*, though sweetish rather than acid, are, *par excellence*, an anti-fever food, being refreshing, palatable, and nutritive, as well as exceedingly digestible. Oranges, biscuits, and cold water, during the critical stage of the disease—milk, bread, and bananas, after the crisis is past—ought to be the standard regimen in our semi-tropical seaport towns; inland and farther north substituting pears or baked apples, and perhaps sweet-potatoes, for bananas, and watermelons for oranges. A frugal diet has the further advantage of obviating the tendency to fretfulness and splenetic humors which results from the use of animal food in indigestible quantities, i. e., in hot weather from a very moderate quantum. In midsummer, persons of a "nervous temper" could often cure their disposition by a change of diet. Mental energy exercises a remarkable influence on the idiopathic symptoms of climatic fevers. Pluck is a febrifuge. Men of exceptional will-force, or under the stimulus of an exceptional enthusiasm, contrive to hold the foe at bay; they keep on their legs till their work is done, even though the presence of a febrile diathesis continues to manifest itself by indirect symptoms. During the carnival of chaos following the end of our civil war and preceding the collapse of the Mexican "Empire," the Sheriff of Cameron County, Texas, undertook to escort a Mexican prisoner across the Rio Grande, in order to save him from a mob who unjustly but obstinately accused him of complicity in the "Cortina riot." It was a ticklish job, but the sheriff, though prostrated by a malignant ague and almost blind from the use of quinine, declined to intrust his *protégé* to a deputy, and preferred to rely on luck and his reputation as a "dead shot." Like most pistol *virtuosos* he was able to fire off-hand, and was confident that no shakiness would interfere with the accuracy of his aim, but was rather uneasy on account of his impaired eyesight. But on the morning of the critical day his fever left him, together with all sequelæ and concomitant symptoms, and he returned, with the conviction that the expedition had saved his own life as well as that of his prisoner.

Even scientific enthusiasm may exercise a similar prophylactic effect, and has supported more than one African explorer and East Indian officer whom no quinine could have saved from the combined influence of solar and animal heat. The trouble is, that the effect is so apt to subside with the cause: heroes and explorers who survive a summer campaign in the wilderness die upon the return to their comfortable winter quarters. The fate of Sir Stamford Raffles is a melancholy instance: A naturalist, a patriot, and a zealous philanthropist, his triple enthusiasm carried him safely through the swampiest regions of the Sunda Archipelago, and, as long as his expedition required his personal presence, Fortune seemed to favor him in every

enterprise; but, upon his return to his palatial residence at Bencoolen, he and all his household were prostrated by the jungle-fever, and, at the end of a life perhaps unequaled for successful activity, he found himself bankrupt, childless, and hopeless. At a time when beef or pork steaks and a bottle of porter were the essentials of a Christian breakfast, a vegetarian official of the East India Company might have defied ill-luck to outweigh the advantage of permanent good health where good health obtained the highest premium. Even now, by their obstinate adherence to their native diet, the British residents of the East Indies are almost decimated every year, especially where the zymotic tendency of that diet is aggravated by the effect of foul air.*

For on the other hand it is equally sure that strict attention to ventilation and a liberal use of cold air and sponge-baths will palliate the effects of many dietetic sins. The patient has either to adapt his diet to the temperature of the South, or adapt his temperature to the diet of the North. Experience has taught the creoles to *take things coolly*. With all their excitable temperament, they avoid violent outbursts of passion; they do not overwork themselves; they preserve the even tenor of their way, even if they are behind time and know that their dinner is getting cold. And, above all, they indulge in liberal *siestas*. Hard work in the hot sun, with a stomach full of greasy viands, obliges the vital force to resist the triple fire of a furnace heated by the sun-rays, by exercise, and by calorific food. Brain-work, too, is apt, in hot weather, to exert an undue strain on the vital energies, and to complicate the difficulties of the digestive apparatus. Cold air is a peptic stimulant, but even in the North a man can not labor with his brain without impeding the labors of his stomach; but, in the languid atmosphere of a southern marsh-land, that impediment becomes an absolute prevention, and the brain-worker who eats for the purpose of nourishing his organism had better save his food for supper than oblige his stomach to carry it for half a day in an undigested condition. For during that half day putrescent decomposition anticipates the work of gastric disintegration; the ingesta ferment, catalytic humors pass into the circulation and prepare the way for the reception and development of zymotic germs from without. The hygienic alternative is, therefore, a long *siesta*, or a considerable postponement of the dinner-hour. South of Cape Hatteras, Nature exacts an account for every superfluous act that tends to raise the temperature of the system by a single degree. *Keep cool* becomes the first commandment of her sanitary code. He who scrupulously avoids anger, enthusiasm, and other calorific passions, who performs the prin-

* "In the [East Indian] jails under British control there are usually confined no fewer than 40,000 prisoners, and the average annual mortality of the whole was recently ten per cent, rising in some cases to twenty-six per cent, or more than *one in four*" (Dr. MacKinnon's "Treatise on the Public Health of Bengal," Cawnpore, 1848, chap. i).

cipal part of the day's work in the cool of the morning, and eats his principal meal in the cool of the evening, who rests during the hottest hour of the afternoon, and takes active exercise only in the swimming-school, may indulge in the dietetic prerogatives of the higher latitudes; Nature will condone his beefsteaks, pork-fritters, and some of his cocktails; his mince-pies will not rise and bear witness against him.

But the happier biped who can waive those prerogatives will free his stomach from the necessity of digesting winter food in a summer climate, and, in return, will enjoy the freedom of the land, the privilege to work, play, eat, rest, laugh, or get mad, at any time he pleases. He has reconciled himself to Nature, and shares the natural rights of the creatures who have not forfeited their earthly paradise; for the artificial comforts of the North are, after all, only more or less imperfect imitations of the gratuitous luxuries which our forefathers enjoyed in their tropical garden home.

## ASSOCIATION OF COLORS WITH SOUNDS.

By HENRI DE PARVILLE.

POPULAR expressions are often very significant. "I saw three dozen lights of all colors," or some similar expression, may frequently be heard from persons who have received violent blows on the head or face. Under the influence of shocks of this kind, the eye really seems to see infinite numbers of sparks. Shocks of a certain class impressed upon the nervous system seem to have the faculty of producing phenomena of light. This remark has been suggested by the facts we are about to relate, which lead us to suppose that sonorous vibrations are susceptible in certain cases of provoking luminous sensations. There are, in fact, persons who are endowed with such sensibility that they can not hear a sound without at the same time perceiving colors. Each sound to them has its peculiar color; this word corresponds with red and that one with green, one note is blue and another is yellow. This phenomenon, "color-hearing," as the English call it, has been hitherto little observed.

Dr. Nussbaumer, of Vienna, appears to have been the first person who took serious notice of it. While still a child, when playing one day with his brother, striking a fork against a glass to hear the ringing, he discovered that he saw colors at the same time that he perceived the sound; and so well did he discern the color that, when he stopped his ears, he could divine by it how loud a sound the fork had produced. His brother also had similar experiences. Dr. Nussbaumer was afterward able to add to his own observations nearly identical ones made by a medical student in Zürich. To this young man, musical

notes were translated by certain fixed colors. The high notes induced clear colors, and the low notes dull ones. More recently, M. Pedrono, an ophthalmologist of Nantes, has observed the same peculiarities in one of his friends. M. Pedrono's friend had become so accustomed to the double perception of sounds and colors that he took no notice of it, and never told it to any one, having forborne to speak of it at the outset for fear of being considered singular. At one time several persons were amusing themselves by repeating in all kinds of applications, as a kind of joke, a slang expression which they had found in some story: "That is as fine as a yellow dog." So everything was declared to be as fine as a yellow dog. "Have you noticed his voice?" said one of the company; "it is as fine as a yellow dog." "Not at all," said M. Pedrono's friend, quickly, "his voice is not yellow, it is pure red." The observation was made in so earnest a manner that the whole company laughed out. "What!" they said, "a red voice! what do you mean?" M. X—— had to explain the curious faculty he had of seeing the color of voices. Each of the company, then, of course, wanted to know what was the color of his own voice, and M. X—— had to satisfy them all. It so happened that one of them had a yellow voice.

According to M. Pedrono, this friend of his had no trouble in his eyes or ears. His hearing was good, his sight perfect, and his general health excellent. Yet the chromatic sensitiveness was so sharp that the luminous impression seemed to be made a little while before the sonorous one; and, before it was possible to judge the quality and intensity of the sound, he had already seen and already knew whether it was red, blue, yellow, or of other color. He did not, like the Zürich student, perceive an appreciable change of color with every modification of tone. A sharp note was only brighter, a flat one duller, than the natural. But, when the same piece was played upon different instruments, varied sensations were produced. A Breton melody gave the sensation of yellow when it was played on a saxophone, red on a clarinet, and blue on the piano, showing that in this case the phenomenon was chiefly influenced by the *timbre*. The intensity of the color corresponds with the energy of the sound. Loud noises bring out brilliant colors. Very sharp tones determine a grayish sensation, that passes to a bright silver-white when they become intense. The human voice gives multifarious impressions. The vowels *i* and *e* (French) produce the most lively colors, *a* and *o* less defined ones, *u* a dark tint. Generally, with this subject, *e* gives yellow, *a* dark blue, *o* red or orange, *u* black. The diphthongs give combined colors: *eu* (French) is gray, *oi* clear gray, *ue* violet.

M. X—— can see all kinds of sounds and noises and distinguish all voices, but, curiously, can not perceive his own. When he is asked for the definite form under which he sees the sounds, he replies that the colored appearance is displayed on the vibrating object, the sonorous body. If the string of a guitar is twanged, that is what is colored;

if the piano is touched, the color appears over the keys. The seat of color, he says, "appears to me to be principally where the sound is made above the person who is singing. The impression is the same if I do not see any one. There is no sensation in the eye, for I think of the same color with my eyes shut. It is the same when the sound comes from the street through walls and partitions. When I hear a choir of several voices, a host of colors seem to shine like little points over the choristers; I do not see them, but I am impelled to look toward them, and sometimes while looking toward them I am surprised not to see them."

These phenomena are strange; possibly the description of them may lead to the discovery of other equally singular examples, and it will become feasible to group them and look for an interpretation of them. It is now a question whether they are hallucinations, like the well-known ones of hearing voices and seeing phantoms, or whether they result from accidental confusion of the auditory and visual nervous fibers. As we now know that there are motor nerve-centers, specially adapted to particular functions, there may be also chromatic centers near the acoustic centers, and these different centers may echo to each other; and the acoustic fibers may cause synchronous vibrations at definite periods of the chromatic fibers. Without multiplying hypotheses, we have pointed out the facts, and must be satisfied to wait for the explanation of them till it is possible to make it.—*Le Monde de la Science et de l'Industrie.*

## THE FORMATION OF SEA-WAVES.

By ÉMILE SOREL.

ONE of the first things to be observed in a storm is the way the wind acts. It does not blow regularly, but in gusts. At one moment it bends over the branches of the trees; in the next, it has loosened its hold, and let them fly back. We see it swelling out a ship's sails into a full puff; a minute later the sails hang flapping as if they had been struck down.

We can account for these phenomena and explain the intermittence of the wind-puffs by assuming that the molecules of air, displacing each other, excite a vibratory movement, which gives rise to little undulations following one after another at intervals of a few seconds. The resultant of a series of these undulations is a puff of wind which comes on suddenly and is followed by a short lull. A series of puffs constitutes a squall, and an aggregation of squalls forms the atmospheric wave which is called a gale of wind. We should naturally expect to observe the same phases in the formation of sea-waves; and,

in fact, if we carefully examine a wave, we shall find that it is covered with very fine ripples, that correspond to the atmospheric vibrations. The ripples give rise to wavelets, which correspond to the undulations of the air, and are seen on the upper part of the waves. The wave proper appears to consist of a series of wavelets. A number of waves constitute a billow; a series of billows gives rise to a heavy sea (*paquet de mer*); a series of heavy seas produces the great swell or tidal wave of the storm.

From the nautical point of view, the ripples are of no importance, for they are seldom more than a few millimetres in diameter; but from the scientific point of view they may be considered as the origin of the swing of the liquid element, for they engender the wavelets. The last are still of no interest to the sailor, but are important in their relation to works of art, which are disintegrated by their blows, apparently insignificant, but infinitely multiplied. The wavelets are from ten to thirty centimetres in diameter and not very long. A very heavy wind breaks them up and contributes to the formation of a fine dust of salt water or salt spray, which is destructive to vegetation on exposed coasts. The wave proper may, in the English Channel, be about ten feet high, thirty feet or more broad, and eighty feet long; its proportions do not disturb large ships, but it is destructive, in the long run, to port works, and is dangerous to small craft when it breaks. We may estimate that ten waves make a billow. The first of the ten may be relatively small, but the others go on increasing to the last.

The heavy seas are the terror of sailors. They represent an enormous volume of water in motion. A gust of wind can not possibly raise up such a mass, and it can only be the result of the combined efforts of the tempest. A heavy sea may reach a height equal to twenty-five or thirty or more feet. It is massive, and strikes like a battering-ram. On the land it causes great damage, and makes breaches in works of earth and stone; at sea, it can send a transatlantic packet to the bottom with a single blow.

The great tidal wave is produced by two causes. On one side, it is the general resultant of the billows and the great seas; and, on the other hand, it is produced by barometrical depressions causing the waters of the ocean to rise. In cyclones, the rise of the water in the center would be neutralized by the centrifugal force, and it is therefore probable that the former cause acts alone. The tidal wave has but small amplitude, but, when inclosed by parallel coasts, it may rise to a height of several metres. It then causes inundations of low shores.

The singular fact has been remarked at Havre that in a storm the swell almost always comes after the tide. The sea rises to its normal high-water mark at the prescribed hour, and then begins to retire as usual; all at once it rises again, to a height generally much greater

than before. This high sea continues for a considerable time, sometimes for several hours; and it has been known to last twenty-four hours.

The billows, heavy seas, and tidal waves possess a considerable inertia, and keep up the swell after the tempest has subsided. The real waves fall, while the billows still subsist, but flattened. It is then easy to estimate the distance between them. On the 26th of March, 1882, I counted eight in a space of four thousand metres.

The most serious event that can take place at sea is a change of wind, such as nearly always occurs in cyclones. The phenomena we have described being well established and sure to continue for a considerable time by virtue of their inertia, when the wind veers around so as to reproduce them in another direction, the new waves cross the old ones, and a chopped sea, dangerous to navigation, is the result.

If any one interested in scientific matters comes to the shore to study the formation of waves, he will experience some disappointment, for the configuration of the coasts, the eddies, and the currents, modify the phenomena in a thousand ways. They are, however, always apparent, even in the calmest weather, and vary only in their amplitude. To observe them it is enough to take notice of the level of the water against a post, a jetty, or other structure. Changes of level are produced there quite similar to the pulsations of the sea; and the extent of these pulsations gives quite exact data respecting everything that we have mentioned.

Waves may be classified as direct waves and waves of transmission. The former, with which the surface of the sea is frequently agitated, are those which the wind raises directly. Waves of the second class may be produced in the calmest weather; their origin is frequently quite distant from the places where they are observed; and they reach those places by transmission. A well-known physical experiment will suggest an explanation of the phenomenon of an agitated and raging sea when there is no wind. If we have a long line of billiard-balls arranged in contact one with another, and give a quick blow to the first one, the last one will roll away. The shock is transmitted from the first ball to the last one, without the intermediate ones suffering any appreciable motion. Marine disturbances caused by direct waves, tides, earthquakes, etc., may in the same way be transmitted through molecules of still water without agitating them. If the liquid space is free, the vibrations are gradually extinguished; if they meet an obstacle, there is a shock. If the obstacle is a shore, they form a tidal-wave and raise large billows, while a few miles away from the shore the sea is quiet. When the obstacle is a shoal or a contrary vibration, heavy waves are raised on the surface of the sea; they seem to start from the bottom, and put ships in great danger. The waves produced in both cases are waves of transmission, as also are those which beat on reefs in pleasant weather, and those which prolong the swell after

storms. The transmission may be effected at very great distances—several hundred miles, for example. It presents a kind of analogy with earthquake-shocks which pass over dead points, and make themselves felt only in places where there are faults or differences in the density of the terrestrial strata.

At Havre, on stormy days, the perturbations of the open sea, transmitted to the shoals of the roadstead, cause oscillations of the water within it, and produce what the sailors call the *levée*, which, in bad weather, prevents the transatlantic steamers from entering the port. Crossing the entrance of the port, with its breakwaters, the *levée* penetrates into the outer harbor and spreads out there, attaining two or three metres in amplitude. It enters the *Bassin du Roi* through a sluice sixteen metres in width, and thence is propagated through a sluice thirteen metres wide to the *Bassin du Commerce*, where, involved in the ins and outs of the quays, it does not reach more than thirty or fifty centimetres in amplitude. This remarkable phenomenon of the *levée*, passing into a chain of basins, appears analogous to that of the vibrations of a tense cord divided into sections by a series of frets in contact with it. When we draw a bow over one of the sections of the cord, the others will also vibrate, while a dead point or node will be formed at each place of contact. In the phenomenon under consideration, the entrance of the port and each sluice give rise to a node.

When a mass of water in motion meets an obstacle, it accumulates against it by virtue of its inertia; the water rises, then falls back. This is called the surf, and may be observed along all coasts. It is produced at sea after every tide. The most curious effect induced by it is the back-flow in rivers. The Seine, for instance, flows rapidly at low water; but, as the tide rises, a liquid obstacle several metres high is piled up in less than two hours against the mouth of the river. The water of the Seine then stops, rises, and falls back as surf, while the surf in its turn acts as an obstacle to the current of the river above it. The phenomenon is repeated, and again, and so on, steadily going higher up the river, so that in effect a strong wave ascends the stream. The phenomenon may be easily reproduced on a small scale; every time we suddenly stop the rapid current of a brook or any stream of water, we may see a back-water ascend it.

The amplitude of the movement of waves remains to be spoken of. It appears to be proportional for direct waves to the force of the wind. On the other hand, since each ripple, wavelet, or wave, occupies a given space, and since, as I have already said, a certain number of these are necessary to give rise to a billow or a heavy sea, it is evident that, with a given wind, a billow of a particular dimension can be formed only if a sheet of water extends over a certain area of surface. This is precisely what takes place, and the dimensions of the billows produced by a given wind appear to be proportional to the extent of the

sea in which they are formed. Thus the largest surface of water to be found on the earth is in the latitude of the Cape of Good Hope; and the strongest waves are met in the neighborhood of this cape. In the Mediterranean the wave is short.

In all ages men have sought for means of calming the agitation of the waves, which is so prejudicial to shipping. The best means hitherto employed has been that of breakwaters, the operation of which is too well known to need description. It may be added that floating wave-breaks, such as would be constituted by a large number of spars or planks left to drift, afford a perfect amelioration of the agitation of the waves. Hitherto engineers have applied their efforts only against the larger waves. Why not attack the evil in its origin? Why not take up the ripples and the wavelets, and oppose them with floating ripple-breaks? Such breaks might be made with twigs, saw-dust, or soot, etc., and experiment has proved that they will be efficacious. The needles of ice which form in cold weather on the surface of the water are excellent natural wavelet-breaks. Generally, every cause hindering the formation of wavelets appeases the agitation of the waves. Thus a rain, every drop of which breaks a ripple, calms the sea to a certain extent. Sailors know this. Billows have been fought against with ordinary wave-breaks. Wavelets may be destroyed by employing light bodies, ripples with dust, microscopic ripples with an infinitely fine powder. A liquid will serve the end admirably. Oil is the best of all agents for the purpose. It has the property (to which capillarity is probably not foreign) of spreading over the water as a pile of billiard-balls spreads over a well-polished marble table. Its molecules form as many floating microscopic pebbles, in the intervals between which the ripples break, as the billows break upon the shingle of the coasts. Oil thus acts as a lubricant, attenuating the friction of the wind. Capillary phenomena, due to the minuteness of the intervals between the oleaginous molecules, intervene to divide up and draw off the surface of the water and completely neutralize the force of the wind. All of these causes together may give us the reason of the efficacy of oil in destroying waves.

It should be understood that all the means of restraining the agitation of waves here indicated are good only against direct waves due to the formation of ripples. They have but slight influence on waves of transmission, which are due to other causes. Oil may appease the billows, but the swell will continue.—*Translated for the Popular Science Monthly from La Nature.*

# MENTAL CAPACITY OF THE ELEPHANT.

By WILLIAM T. HORNADAY.

ACCORDING to the popular idea, *man* is the only animal endowed with reason. Even after modern scientific classification forced from all the humiliating admission that man is an animal, the idea of his supreme superiority over all the rest of the animal kingdom was embalmed in the formula, "Man is a reasoning being." The reasoning faculty is, to the popular mind, the gulf which separates him from the so-called dumb brutes, wide, fathomless, and impassable. While there are many who believe that this gulf which separates reason from absence of reason is occasionally bridged over, as it were, in the case of individual animals of phenomenal intelligence, there are a few who deny its existence altogether. Whenever enough evidence is accumulated to compel the unconditional surrender of the ground man has assigned for his exclusive occupancy, whenever it is clearly and conclusively shown that man's intellectual supremacy over the lower animals is due to the degree and not to the quality of his intellect, it will mark the beginning of a new era in psychological thought.

The principal purpose of this paper is to show the scope and quality of intelligence displayed by the animals of a certain species, the elephant, and to afford some data for a comparison of the mental processes of this animal with those of man.

Of late years, or we may even say during the last decade, the question as to whether any of the lower animals are ever capable of reasoning has been often discussed. Hundreds of instances of unusual intelligence displayed by domestic animals have been related, and in many cases the actions of certain individuals have been admitted to be the result of reasoning. The dog has furnished a far greater number of such instances than any other animal, but we believe that this is due not so much to his superior intelligence as to the fact that he is brought into closer relations with his master, man, than is any other animal. A great many stories are told of the horse, cat, and elephant, and a few others detailing the performances of three or four remarkably intelligent chimpanzees and orangs have been repeated until they are now worn threadbare. Siamangs, baboons, and other members of the monkey tribe, parrots, canaries, and even fleas, have also attracted attention by their intelligent independent actions, or their performances under training. It appears that by universal consent the dog has been given the first place in the arrangement of animals according to their intelligence. Dr. W. L. Lindsay, however, who has made a careful, critical, and highly elaborate study of the subject of "Mind in the Lower Animals," thus arranges the orders of mammalia in a descend-

ing series according to the degree of intelligence manifested by their most gifted members:

1. *Bimana*, higher man only, however,
2. *Quadrumana*, especially the larger anthropoid apes.
3. *Carnivora*, including especially the dog and cat.
4. *Proboscidia*, the elephant.
5. *Ungulata*, especially the horse, mule, and ass.
6. *Rodentia*, especially the beaver and rat.

Apparently the elephant has always been regarded as an animal of third or fourth rate intelligence, as compared with common domestic animals and the great apes. Cuvier, in his "Règne Animal," records his conviction that in sagacity the elephant in no way excels the dog, and some other species of carnivora. Sir Emerson Tennent, even after a careful study of the elephant, is disposed to award the palm for mental superiority to the dog, but he hastens to add, "not from any excess of natural capacity, but from the higher degree of development consequent on his more intimate domestication and association with man."

Surprising as these opinions may seem in the light of certain facts to be presently adduced, much more surprising is the opinion of Mr. G. P. Sanderson, who has been more intimately associated with elephants than any man living. After several years' continuous service, entirely devoted to the capture of wild herds and their management while under training in captivity, he writes as follows of the Indian elephant:

"Its reasoning faculties are undoubtedly far below those of the dog, and possibly of other animals; and in matters beyond the range of its daily experience it evinces no special discernment. While quick at comprehending anything sought to be taught to it, the elephant is decidedly wanting in originality."

An opinion from such an authority is entitled to great weight in a consideration of the entire subject, and it is possible that Sanderson's estimate of the elephant's powers of original reasoning is correct; but in the mind of the writer there is no question of the elephant's *general* intellectual superiority over all other animals, except higher man. More than this, I believe that the hitherto universal failure to recognize this fact has been a *real loss* to the student of psychology.

While the subject-matter of this article has been drawn almost wholly from observations of the Indian, or Asiatic, elephant both in a wild state and under various conditions of captivity, there is no evidence whatever to prove that, according to an idea which has quite generally prevailed, the African elephant is less intelligent and tractable than his East Indian congener. While many intelligent people have been led to believe that *Africanus* can not be trained to service at all, actual proof of his intellectual inferiority is wholly wanting, and there is no good reason for believing that *any* can be found. Whenever it

becomes necessary to accumulate evidence in his favor, the task will be a simple and easy one.

Ælian and Pliny describe the performances of African elephants in the amphitheatre at Rome, the former with considerable detail. African elephants were used by the Carthaginians in their wars with the Romans, but it is stated by the historian Armandi that, from inexperienced and deficient training, they proved less effective than the elephants of India.

A gentleman who lately arrived in this city from the west coast of Africa informed the writer that he had just seen at St. Paul de Loanda an African elephant, considerably larger and older than Jumbo, at work loading timbers into a ship, and that the animal performed his tasks with surprising intelligence and precision.

The Indian elephant's reputation for mental superiority over the African is apparently due to accidental circumstances. It is true that trained elephants of the former species outnumber the African by perhaps more than sixty to one, but it is also true that in Africa the inhabitants are mostly negro savages who have neither the resources, intelligence, nor inclination necessary to the wholesale capture and domestication of elephants. Unlike the inhabitants of Hindostan, Ceylon, Burmah, and Siam, who from time immemorial have made a business of the capture and training of wild elephants, the negroes of Africa look upon the elephant only as an ivory-producer. The splendid tusks of *Africanus* make his total extermination only a question of time. Long before the world will have reached the necessity of utilizing this animal as a beast of burden, the ivory hunters will have finished their war of extermination, now being waged with such alarming success, and the chances are that the zoölogist of the future will describe this animal as so entirely inferior to the Indian species, both in intelligence and temper, that only a few individuals were ever successfully trained. It is the misfortune of *Africanus* that he belongs to the undeveloped continent. Two centuries hence, when the last of his race goes to join the mammoth and the mastodon, his captive congener in India will still be devouring his four hundred pounds of green fodder per day, in peaceful domestication, while in the jungles, the progeny of the wild herds which now roam the forests, secure from destruction under the stringent English laws, will still be protected for the perpetuation of the species.

The intelligence of an animal may be measured by taking into account, separately, its *intellectual qualities*, as follows:

1. Powers of independent reasoning or observation.
2. Memory.
3. Comprehension under tuition.
4. Accuracy in the execution of man's orders.

Closely allied to these are the *moral qualities* which go to make up an animal's temperament and disposition, about as follows:

1. Amiability, which guarantees security to his human associates.
2. Patience, or submission to discipline and training.
3. Courage, which gives self-confidence and steadiness.
4. A disposition to obedience, with cheerfulness.

Before entering upon a discussion of the intellectual powers and moral qualities of the elephant in accordance with the outlines just given, I wish to state that in matters involving facts I shall confine myself strictly to my own observations made on *Elephas Indicus*, except where otherwise stated. A point to which we ask special attention from beginning to end is, that in endeavoring to estimate the mental capacity of the elephant, we shall base no arguments upon any *particularly intelligent individual* of a given race or species, as is *always* done in discussions of intelligence in the dog, the cat, the horse, parrot, and ape. On the contrary, it is the intention to reveal the mental capacity of *every elephant living*, tame or wild, of both the Indian and African species, except a few individuals with diseased minds. It is not to be shown how successfully *an* elephant has been taught by man, but how *all* elephants in captivity have been taught, and what *every* wild elephant is known to be capable of. In endeavoring to determine the mental status of the dog, horse, cat, ape, or elephant, or even human beings, the *average intelligence of all the members of an entire species*, or at least an entire race, should be the objective point of the inquiry.

Under the head of intellectual qualities we have first to consider the elephant's

*Powers of Independent Observation and Reasoning, or Reasoning from Cause to Effect.*

While many wonderful stories are related of the elephant's sagacity and independent powers of reasoning, it must be admitted that an indefinitely greater number of much more wonderful anecdotes are told on equally good authority of dogs. But the circumstances in the case are wholly to the advantage of the dog, and against the elephant. While the former roams at will through his master's house and out-door premises, through town and country, mingling freely with all kinds of men and domestic animals, with unlimited time and liberty to lay plans and execute them, the elephant in captivity is chained to a stake, with no liberty of action whatever, aside from eating and drinking, and amusing himself by swaying his body, swinging one foot, or switching his tail. Such a ponderous beast can not be allowed to roam at large among human beings, and he never leaves his stake and chain except under the guidance of his *mahout*, who directs his every act. There is no telling what wonderful powers of reasoning captive elephants might develop if they could only enjoy the freedom accorded all dogs, except the blood-hound, bull-dog, and a few others.

But in our dealings with incontestable facts none of the many sagacity-stories alluded to can be used. We are, therefore, for the reasons just given, compelled to find the most of our evidences of independent reasoning in *wild* elephants. The writer has frequently seen wild elephants—

1. Reconnoitre dangerous ground by sending a scout or spy.
2. Communicate intelligence by signs.
3. Retreat in orderly silence from a lurking danger.
4. Invariably march in single file, like the jungle tribes of men.

Having on one occasion in hunting elephants approached to within fifty yards of the stragglers of a large herd of about thirty animals, which was scattered over about four acres of very open forest and quietly feeding, certain individuals of the herd on the side nearest us suddenly suspected danger. One of them elevated his trunk with the tip bent forward, and scented the air from various points of the compass, a sure sign of danger suspected. A moment later an old elephant left the herd and started straight for our ambush, scenting the air with upraised trunk as he slowly and noiselessly advanced. We instantly retreated, unobserved and unheard, and the elephant advanced until he reached the identical spot where we had a moment before been concealed. He paused and stood motionless as a statue for about two minutes, then wheeled about and quickly but noiselessly rejoined the herd. In less than half a minute the whole herd was in motion, heading directly away from us, moving very rapidly but *without the slightest noise.* The huge animals simply vanished like shadows into the forest. The entire herd formed in single file before proceeding a quarter of a mile, and continued strictly in that order, one directly behind another, for several miles. Like the human dwellers in the jungle, the elephants know that the easiest and most expeditious way for a large body of animals to traverse a tangled forest is for the leader to pick the way, while all the rest follow in his footsteps.

In strong contrast with the stealthy and noiseless manner in which elephants steal away from a lurking danger or ambush discovered, from an open attack, accompanied with the noise of fire-arms, they rush away at headlong speed, quite regardless of the noise they make. On one occasion a herd which I was designing to attack, and had approached to within forty yards on one side, as they were feeding in some thick bushes, discovered my presence and retreated so silently that they had been gone five minutes before I discovered what their sudden quietude really meant. In this instance, also, the alarm was communicated by silent signals, or *sign-language.*

Tame elephants are never known to tread on the feet of their attendants or knock them down by accident; or, at least, no instances of the kind have ever come to my knowledge. The elephant's feet are very large, his range of vision is very circumscribed, and his ex-

treme and wholly voluntary solicitude for the safety of his human attendants can not be due to anything else than independent reasoning. The most intelligent dog is apt to greet his master by planting a pair of dirty paws on his coat or trousers. The most sensible carriage-horse is liable to step on his master's foot or crowd him against a wall in a moment of excitement; but even inside the *keddah*, with wild elephants all about, and a captive elephant hemmed in by two, three, or four tame ones, the noosers actually work under the bodies and between the feet of the tame animals until the feet of the captive are tied.

All who have witnessed the tying of captives, one by one, in a keddah, wherein a whole wild herd have been entrapped, testify to the human-like quality of intelligence displayed by all the tame elephants who assist in the tying and leading out and subjugation of the captives. They enter into the business with both spirit and understanding, and as occasion requires will deceitfully cajole or vigorously punish a troublesome captive. Sir Emerson Tennent asserts that the tame elephants display the most perfect conception of every movement, both of the object to be attained and the means to accomplish it. While this statement probably exceeds the exact truth, it truthfully conveys the impression made upon the beholder.

We come now to the second intellectual quality, or MEMORY.

So far as this may be regarded as an index of an animal's mental capacity, the weight of evidence is overwhelmingly in favor of the elephant. Every one who attended either Barnum's or Forepaugh's circus during the last year witnessed an imitation military drill performed by from twelve to sixteen elephants, which, in animals of any other species, would be considered a most remarkable performance. The following were the commands given by the trainer, understood and remembered by each elephant, and executed without an instant's hesitation or any mistake. These we will call the

*Accomplishments of Performing Elephants.*

1. Fall in line.
2. Roll-call. (As each elephant's name is called, he takes his place in another rank.)
3. Present arms. (Trunk uplifted, with tip curved forward and held in that position for a short time.)
4. Forward, march.
5. File left, march.
6. Right about face, march.
7. Left about face, march.
8. Right by twos, march.
9. Double quick, march.
10. Single file, march.
11. File right.

12. Halt.
13. Ground arms. (All lie down, and lie motionless.)
14. Attention. (All get up.)
15. Shoulder arms. (All stand up on their hind-legs.)

In all, fifteen commands obeyed by the whole company of elephants.

It being impossible, or at least impracticable, to supply so large a number of animals with furniture and stage property for a further universal performance, certain individuals were supplied with the proper articles when necessary, for a continuation of the performance, as follows:

16. Ringing bells.
17. Climbing up a step-ladder.
18. Going lame in a fore-leg.
19. Going lame in a hind-leg.
20. Stepping up on a tub turned bottom up.
21. Standing on a tub on two right-legs only.
22. The same, on opposite fore- and hind-leg.
23. The same, on the fore-legs only.
24. The same, on the hind-legs only.
25. Using a fan.
26. Turning a hand-organ.
27. Using a handkerchief to wipe the eyes.
28. Sitting in a chair.
29. Kneeling, on the knees proper.
30. Kneeling on "fore-knees" (so called), or wrists.
31. Walking astride a man lying lengthwise.
32. Stepping over a man lying crosswise.
33. Forming a pyramid of elephants by using tubs of various sizes.

While it is true that every act in the latter part of this performance was not participated in by every one of the elephants who went through the military drill, there is no room for doubt of the entire ability of each individual to understand the meaning of the whole thirty-three commands, and to remember them all accurately and without confusion. The most astonishing feature of the performance was, aside from the perfect obedience of the huge beasts, their power of memory, which is without a parallel in the history of trained animals.

We come now to a consideration of the

### *Accomplishments of Working Elephants.*

In all the timber-forests of Southern India every captive elephant is taught to perform all the following acts and services, as I have witnessed on many occasions:

1. To *salaam*, or salute, by raising the trunk.
2. To kneel, to receive a load or a passenger.
3. When standing, to hold up a fore-foot, to serve the driver as a block in climbing to his place.

4. To lie down to be washed, first on one side and then on the other.

5. To open the mouth.

6. To "hand up" any article from the ground to the reach of a person riding.

7. To pull down an obstructing bough.

8. To halt.

9. To back.

10. To pick up the end of a drag-rope and place it between the teeth.

11. To drag a timber.

12. To kneel and with the head turn a log over, or turn it with the tusks if any are present.

13. To push a log into position parallel with others.

14. To balance and carry timbers on the tusks, if possessing tusks of sufficient size.

15. To "speak," or trumpet.

16. To work in harness.

In all, sixteen distinct acts.

Every working elephant in India is supposed to possess the intelligence necessary to the performance of any of the acts enumerated above at the command of his driver, either by spoken words, a pressure of the knees or feet, or a touch with the driving goad. For the sake of generalization I have purposely excluded from this list all tricks and accomplishments which are not universally taught to working elephants. We have seen, however, that performing elephants are capable of executing nearly double the number of acts commonly taught to the workers; and, while it is useless to speculate upon the subject, it must be admitted that, were a trainer to test an elephant's memory by ascertaining the exact number of commands it could remember and execute in rotation, the result would far exceed anything yet obtained. For my own part, I believe it would exceed a hundred, if not many times that figure. The performance in the circus-ring is limited by time and space, and not by the mental capacity of the elephants.

When we come to consider the comparative comprehension of animals under man's tuition, we find the elephant without a rival.

On account of the fact that an elephant is about eighteen years in coming to anything like maturity, according to the Indian Government standard for working animals, it is far more economical and expeditious to catch full-grown elephants in their native jungles than it would be to breed and rear them. About ninety per cent of all the elephants now living in captivity were caught in a wild state and tamed, and of the remainder at least eight per cent were born in captivity of females that were gravid when captured. It will be seen, therefore, that the elephant has derived no advantage whatever from ancestral association with man, added to the most careful selection and breeding which, all combined, have made the colly, the pointer, and the setter

the wonderfully intelligent animals they are. For many generations the horse has been bred for strength, for speed, or for beauty of form, but the breeding of the dog has been based *chiefly* on his intelligence. With all his advantages, his comprehensive faculties, even in the most exceptional individuals of a whole race, are not to be compared to those of any adult elephant fresh from the jungle.

The extreme difficulty in teaching a dog of mature age even the simplest thing is so well known that it has passed into a proverb: "It is hard to teach an old dog new tricks." In other words, the conditions *must* be favorable. What is the case with the elephant? The question shall be answered by Sanderson. In his "Wild Beasts of India," he says: "Nor are there any elephants which can not be easily subjugated, whatever their size or age. The largest and oldest elephants are frequently the most easily tamed, as they are less apprehensive than the younger ones."

The most striking feature in the education of an elephant is the suddenness of his transition from a wild and lawless denizen of the forest to the quiet, plodding, good-tempered, and cheerful beast of draught or burden. There takes place in the keddah, or pen of capture, a mighty struggle between the giant strength of the captive and the ingenuity of man, ably seconded by a few powerful tame elephants. When he finds his strength utterly overcome by man's intelligence, he yields to the inevitable, and accepts the situation philosophically. Sanderson once had a narrow escape from death while on the back of a tame elephant inside a keddah attempting to secure a wild female. She fought his elephant long and viciously, with the strength and courage of despair, but she was finally overcome by superior numbers. Although her attack on Sanderson in the keddah was of the most murderous description, he states that her conduct after her defeat was most exemplary, and she never afterward showed any signs of ill-temper.

Mr. Sanderson and an elephant-driver once mounted a full-grown female elephant on the sixth day after her capture, without even the presence of a tame animal. Sir Emerson Tennent records an instance wherein an elephant fed from the hand on the first night of its capture, and in a very few days evinced pleasure at being patted on the head. Such instances as the above can be multiplied indefinitely. To what else shall they be attributed than philosophic reasoning on the part of the elephant? The orang-outang, so often put forward as his intellectual superior, when captured alive at any other period of life than that of helpless infancy, is vicious, aggressive, and intractable for weeks and months, if not during the remainder of its life. Orangs captured when fully adult exhibit the most tiger-like ferocity, and are wholly intractable.

If dogs are naturally superior to elephants in general intellect, it should be as easy to tame and educate newly-caught wild dogs or

wolves of mature age as newly-caught elephants. But, so far from this being the case, it is safe to assert that it would be *impossible* to train the most intelligent company of pointers, setters, or collies ever got together to perform the feats accomplished with such promptness and accuracy by all regularly trained circus-elephants.

The successful training of all elephants up to the required working point is so fully conceded in India that the market value of an animal depends wholly upon his age, sex, build, and the presence or absence of good tusks. The animal's education is either sufficient for the buyer, or, if not, he knows it can be made so.

The time required for the training of newly-captured elephants, and fitting them for all kinds of work, varies from four to six months, although instances are known wherein some have been worked in harness two months after capture.

The fourth quality, which serves as a key to the mental capacity and mental processes of an animal, is the degree of its

*Promptness and Accuracy in the Execution of Man's Orders.*

The most impressive feature of a performance of elephants in the circus-ring is the fact that every command uttered is obeyed with true military promptness and freedom from hesitation, and so accurately that an entire performance is often conducted and concluded without the repetition of a single command. One by one the orders are executed with the most human-like precision and steadiness, amounting sometimes to actual nonchalance. Human beings of the highest type could scarcely do better. To some savage races—for example, the native Australians, the veddahs of Ceylon, or the jackoons of the Malay Peninsula—I believe such a performance would be impossible, even under training. I do not believe their minds act with sufficient rapidity and accuracy to enable a company of them to go through with such a wholly artificial performance as successfully as the elephant's.

The thoughtful observer does not need to be told that the brain of the ponderous quadruped acts, *as far as it goes*, with the same lightning rapidity and clearness as that of the most intelligent man—this, too, be it remembered, in a performance wholly artificial and acquired, in which the animal depends solely upon the *words* of the trainer. I particularly noted the fact that the performance of Barnum's elephants was conducted without the use of any signs whatever.

In the performance of Bartholomew's horses, of which I once kept a record in detail, even the most accomplished members of his stud often had to be commanded again and again before they would obey. A command was often repeated for the sixth time before the desired result was obtained. I noted particularly that not one of his horses, which are perhaps the most fully trained of any living, was an exception to this rule, or performed his tasks with the prompt obedience and self-confidence so noticeable in every one of the sixteen elephants. The horses

usually obeyed with tardiness and hesitation, and very often manifested nervousness and uncertainty.

In the mind of the elephant, e. g., *each* elephant, there was no confusion of ideas, but, on the contrary, a mental grasp on the whole subject, so secure and comprehensive that the animal felt himself master of the situation.

I have never yet seen a performance of trained dogs which could be considered worthy of serious comparison with the accomplishments of either performing or working elephants. In the matter of educational capacity the dog can not on any grounds be considered the rival of the elephant. The alleged mental superiority of the dog is based almost wholly upon his powers of independent reasoning and observation as exhibited in a state of almost perfect freedom. Until the educated elephant, who has grown to maturity under man's influence, is allowed the dog's freedom to plan and execute, no comparison can be made between them in this respect.

Finally, we come to a consideration of the elephant's moral qualities, but it is not pertinent to this inquiry to discuss more than those having a direct bearing upon the subject. In India the elephant bears a spotless reputation for patience, amiability, and obedience, except in the case of such individuals as have been afflicted with insanity, either temporary or permanent. I know of no instances on record wherein an elephant has been guilty of culpable homicide, or even of attempting it. I have never heard of an elephant in India so much as kicking, striking, or otherwise injuring either human beings or other domestic animals. There have been several instances, however, of persons killed by elephants which were temporarily insane, or "*must*," and also by others permanently insane. It is the misfortune but not the fault of the elephant that in advanced age and by want of necessary exercise he is liable to be attacked by a fit of *must*, during which period he is clearly irresponsible for his acts.

So many men have been killed by elephants in this country that the idea has of late years been steadily gaining ground that they are naturally ill-tempered and vicious to a very dangerous extent. Nothing could be further from the truth. We have seen that in the hands of the "gentle Hindoo" the elephant is gentle and reliable, and never attacks man except under the circumstances already stated. In this country, however, where he is at the mercy of quick-tempered and sometimes brutal showmen, who very often do not understand the temperament of the animals under their control, and who during the traveling season are rendered perpetually ill-tempered and vindictive by reason of overwork and insufficient sleep—with such masters as these to mete out punishment, without judgment or reason, it is no wonder that the animal occasionally rebels, and executes vengeance. I am convinced that an elephant could by ill-treatment be driven to insanity, and I have no doubt this has been done more than once in this country.

When commanded by man, the elephant will tear a criminal limb from limb, or crush him to death with his knees, or go out to battle holding a cimeter in his trunk. He will, when told to do so, attack his kind with fury and persistence; but, in the course of many hours, or even days, spent in watching wild herds, I never yet saw a single individual show any signs of impatience or ill-temper toward his fellows.

It is safe to say that, thus far, not one half the elephant's mental capabilities have been developed or even understood. It would be of great interest to determine by experiment the full educational capacity of this interesting quadruped, and, but for the lack of a permanent menagerie in this city, it would ere now have been undertaken. It would be equally interesting to determine the exact limit of its reasoning powers in applied mechanics. An animal that can turn a hand-organ with regularity at the proper speed, can be taught to push a smoothing-plane invented purposely for him; but whether he would learn of himself to plane the rough surfaces smooth, and let the smooth ones remain untouched, is an open question.

While it is generally fruitless and unsatisfactory to enter the field of speculation, I can not resist the temptation to assert my belief that an elephant can be taught to read written characters, and also to express some of his own thoughts or states of feeling in writing. It would be a perfectly simple matter to prepare suitable appliances by which the sagacious animal could hold a crayon in his trunk, and mark upon a surface adapted to his convenience. In Ælian's work on "The Nature of Animals," eleventh chapter of the second book, he describes in detail the wonderful performances of elephants at Rome, all of which he saw. One passage is of peculiar interest to us, and the following is a translation of it: ". . . I saw them writing letters on Roman tablets with their trunks, neither looking awry nor turning aside. The hand, however, of the teacher was placed so as to be a guide in the formation of the letters; and, while it was writing, the animal kept its eye fixed down in an accomplished and scholar-like manner."

I can conceive how an elephant may be taught that certain characters represent certain ideas, and that they are capable of intelligent combination. The system and judgment and patient effort which developed an active, educated, and even refined intellect in Laura Bridgman—deaf, dumb, and blind from birth—ought certainly to be able to teach a clear-headed, intelligent elephant to express at least *some* of his thoughts in writing. In this way it may, some day, be possible to open a channel for the communication of thought between man and the lower animals; in this way it may be possible to prove, beyond all possibility of dispute, the presence of the true reasoning faculty in other animals than man. That it does exist, to a greater or less degree, in all vertebrate animals, I have no doubt whatever. I believe

that elephants have immortal souls as much as men, and are, as a species, far more deserving of immortality. I believe it is as much an act of murder to wantonly take the life of a healthy elephant as to kill a native Australian or a Central-African savage. If it is more culpable to kill a highly developed man than an elephant, it is also more culpable to kill an elephant than an echinoderm. Many men are both morally and intellectually lower than many quadrupeds, and are, in my opinion, as wholly destitute of that indefinable attribute called the soul as all the lower animals are commonly supposed to be.

If an investigator like Darwin or an educator like Dr. Howe should take it in hand to develop the mind of the elephant to the highest possible extent, his results would be awaited with peculiar interest, and it would be strange if they did not necessitate a revision of the theories now common among those who study the purely speculative portion of theology, which is based on man's immortal soul.

## THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

### VII.

A SHEEP or an ox, a fowl or a rabbit, is made up, like ourselves, of organic structures and blood, the organs continually wasting as they work, and being renewed by the blood; or, otherwise described, the component molecules of these organs are continually dying of old age as their work is done, and replaced by new-born successors generated by the blood.

These molecules are, for the most part, cellular, each cell living a little life of its own, generated with a definite individuality, doing its own life-work, then shriveling in decay, dying in the midst of vital surroundings, suffering cremation, and thereby contributing to the animal heat necessary for the life of its successors, and even giving up a portion of its substance to supply them with absorption-food. The cell-walls are mainly composed of gelatine, or the substance which produces gelatine, as already explained, while the contents of the cell are albuminous matter or fat, or the special constituents of the particular organ it composes. A description of all these constituents would carry me too far into details. I must, therefore, only refer to those which constitute the bulk of animal food, and which are altered in the process of cooking.

In the lean of meat, i. e., the muscles of the animal, we have the albuminous juices already described, the gelatinous membranes, sheaths, and walls of the muscular fiber, and the fiber itself. This is composed of *muscular fibrin*, or *syntonin*, as Lehmann has named it. Living

blood consists of a complex liquid, in which are suspended a multitude of minute cells, some red, others colorless. When the blood is removed and dies, it clots or partially solidifies, and is found to contain a network of extremely fine fiber, to which the name of *fibrin* is applied. A similar change takes place in the substance of the muscle after death. It stiffens, and this stiffening, or *rigor mortis*, is effected by the formation of a clot analogous to the coagulation of the blood, and the substance of this clot (*myosin*) is so nearly like the fibrin of the blood and the material of the muscular fiber (*syntonin*) that for our purpose they may be all described as varieties of fibrin.

The properties of fibrin, so far as cookery is concerned, place it between albumen and gelatine; it is coagulable like albumen, and soluble like gelatine, but in a minor degree. Like gelatine, it is tasteless, and non-nutritious *alone*. This has been proved by feeding animals on lean meat, which has been cut up and subjected to the action of cold water, which dissolves out the albumen and other juices of the flesh, and leaves only the muscular fiber and its envelopes. The same is the case with the spontaneously coagulated fibrin of the blood; it is, when washed, a yellowish, opaque, fibrous mass, without smell or taste, insoluble in cold water, alcohol, or ether, but imperfectly soluble if digested for a considerable time in hot water.

The following is the chemical composition of these three constituents of lean meat, according to Müller:

| | Albumen. | Gelatine. | Fibrin. |
|---|---|---|---|
| Carbon | 53·5 | 50·40 | 52·7 |
| Hydrogen | 7·0 | 6·64 | 6·9 |
| Nitrogen | 15·5 | 18·34 | 15·4 |
| Oxygen | 22·0 | 24·62 | 23·5 |
| Sulphur | 1·6 | .... | 1·2 |
| Phosphorus | 0·4 | .... | 0·3 |
| | 100·0 | 100·00 | 100·0 |

There are two other constituents of lean meat which are very different from either of these, viz., *Kreatine* and *Kreatinine*, otherwise spelled creatine and creatinine. These exist in the juice of the flesh, and are freely soluble in cold or hot water, from which solution they may be crystallized by evaporating the solvent, just as we may crystallize common salt, alum, etc. They thus have a resemblance to mineral substances, and still more so to some of the active constituents of plants, such as the alkaloids, *theine*, and *caffeine*, upon which depend the stimulating or "refreshing" properties of tea and coffee.

Their chemical composition and general relations have suggested the theory that they are the dead matter of muscle, the first and second products of the combustion which accompanies muscular work, urea being the final product. According to this, their relation to the muscle is exactly the opposite of that of the albuminous juice, this

being probably the material from which the muscle is built up or renewed. The following is their composition, according to Liebig's analyses :

| | Kreatine. | Kreatinine. |
|---|---|---|
| Carbon | 36·64 | 42·48 |
| Hydrogen | 6·87 | 6·19 |
| Nitrogen | 32·06 | 37·17 |
| Oxygen | 24·43 | 14·16 |
| | 100·00 | 100·00 |

The juices of lean flesh also contain a little lactic acid—the acid of milk—but this does not appear to be an absolutely essential constituent. Besides these there are mineral salts of considerable nutritive importance, though small in quantity. These, with the kreatine and kreatinine, are the chief constituents of beef-tea, properly so called, and will be further treated when I come to that preparation. At present it is sufficient to keep in view the fact that these juices are essential to complete the nutritive value of animal food.

I may now venture to state my own view of a somewhat obscure subject, viz., the difference between the roasting or grilling and the stewing of meat. It appears to me that, with the exception of the superficial "browning," it consists simply in the difference between the cooking media ; that a grilled steak or chop or a roasted joint is meat that has been stewed in its own juices instead of stewed in water ; that in both cases the changes taking place in the solid parts of the meat are the same in kind, provided always that the roasting or grilling is properly performed. The albumen is coagulated in all cases, and the gelatinous and fibrous tissues are softened by being heated in a liquid solvent. I shall presently apply this definition in distinguishing between good and bad cookery.

In the roasted or grilled meat the juices are retained in the meat (with the exception of that which escapes as gravy on the dish), while in stewing the juices go more or less completely into the water, and the loosening of the fibers and solution of the gelatine and fibrin may be carried further, inasmuch as a larger quantity of solvent is used.

Roasting and grilling may be regarded as our national methods of flesh cookery, and stewing in water that of our Continental neighbors. The difference between the flavor of English roast beef and French *bouilli* or Italian *manzo* is due to the retention or the removal of the saline and highly flavored soluble materials. (Concentrated kreatine and kreatinine are pungently sapid.) The Frenchman takes them out of his *bouilli*, or boiled meat, and transfers them to his *bouillon*, or soup, which with him is an essential element of a meal. If he ate his meat without soup, he would be like the dogs fed on gelatine by the bone-soup commissioners. To the Englishman, with his roast or grilled

meat, soup is merely a luxury, not a necessary element of complete dietary.

What we call boiled meat, as a boiled leg of mutton or round of beef, is an intermediate preparation. The heat is here communicated by water and the juices partially retained.

NOTE.—A correspondent tells me that he has tried the method of cooking eggs which I recommended, and he states that his eggs "were not cooked at all." From what I can learn by his letter, he omitted to attend to the quantity of water I named, viz., *about a pint.*

As this is of essential importance, I should perhaps have stated it with some emphasis. More than a pint of water should be used rather than less, as upon the quantity of water depends the retention of the heat. If the quantity of water is smaller, it should be kept boiling about half a minute before setting aside.

VIII.

The application of the principles already expounded to the processes of grilling and roasting is simple enough. As the meat is to be stewed in its own juices, it is evident that these juices must be retained as completely as possible, and that in order to succeed in this we have to struggle with the evaporating energy of the "dry heat" which effects the cookery.

It should be clearly understood that the so-called "dry heat" may be communicated by convection or by radiation, or both. When water is the heating medium, there is convection only, i. e., heating by actual contact with the heated body. In roasting and grilling there is also some convection-heating due to the hot air which actually touches the meat; but this is a very small element of efficiency, the work being chiefly done, when well done, by the heat which is radiated from the fire directly to the surface of the meat, and which, in the case of roasting in front of a fire, passes through the intervening air with very little heating effect thereon.

I am not perpetrating any far-fetched pedantry in pointing out this difference, as will be understood at once by supposing that a beefsteak should be cooked by suspending it in a chamber filled with hot dry air. Such air is actively thirsting for the vapor of water, and will take into itself, from every humid substance it touches, a quantity proportionate to its temperature. The steak receiving its heat by convection, i. e., the heat conveyed by such hot air, and communicated by contact, would be *desiccated, but not cooked.*

This distinction is so important that I will illustrate it still further, my chief justification for such insistence being that even Rumford himself evidently failed to understand it, and it has been generally misunderstood or neglected.

Let us suppose the hot air used for convection cooking to be at the cooking-point, as the hot water in stewing should be, what will follow its application to the meat? Evaporation of the water in the juices, and with that evaporation a lowering of temperature at the surface of

the meat, keeping it below the cooking-point. If the air be heated above this, the evaporation will go on with proportionate rapidity, and as nearly one thousand degrees of heat are lost *as temperature*, and converted into expansive force whenever and wherever evaporation of water occurs, the film of hot, dry air touching the meat is cooled by this evaporation, and sinks immediately, to be replaced by a rising film of lighter, hotter, and drier air, which drinks in more vapor, cools and sinks, to give place to another, and so on till the inner juices gradually ooze between the fibers to the porous surface, where they are carried away by the hot, dry air, and a hard, leathery, unmasticable mass of desiccated gelatine, albumen, fibrin, etc., is produced, which, if given to a dog for the purpose of watching its effect on the animal, would render an unlicensed experimenter liable to prosecution under the vivisection act.

Now, let us suppose a similar beefsteak to be cooked by radiant heat, with the least possible co-operation of convection.

To effect this, our source of heat must be a good radiator. Glowing solids are better radiators than ordinary flames; therefore coke, or charcoal, or ordinary coal, after its bituminous matter has done its flaming, should be used, and the steak or chop may be placed in front or above a surface of such glowing carbon. In ordinary domestic practice it is placed on a gridiron above the coal, and therefore I will consider this case first.

The object to be attained is to raise the juices of the meat throughout to about the temperature of 180° Fahr. as quickly as possible, in order that the cookery may be completed before the water of these juices shall have had time to evaporate to any considerable extent; therefore the meat should be placed as near to the surface of the glowing carbon as possible. But the practical housewife will say that, if placed within two or three inches, some of the fat will be melted and burn, and then the steak will be smoked.

Now, here we require a little more chemistry. There is smoking and smoking—smoking that produces a detestable flavor, and smoking that does no mischief at all beyond appearances. The flame of an ordinary coal-fire is due to the distillation and combustion of tarry vapors. If such a flame strikes a comparatively cool surface like that of the meat, it will condense and deposit thereon a film of crude coal-tar and coal-naphtha, most nauseous and rather mischievous; but, if the flame be that which is caused by the combustion of its own fat, the deposit on a mutton-chop will be a little mutton-oil, on a beefsteak a little beef-oil, more or less blackened by mutton-carbon or beef-carbon. But these oils and carbons have no other flavor than that of cooked mutton and cooked beef; therefore they are perfectly innocent, in spite of their guilty black appearances.

If any of my readers are skeptical, let them appeal to experiment, by putting a mutton-chop to the torture, and taking its own confes-

sion. To do this, divide the chop in equal halves, then hold one half over a flaming coal, immersing it in the flame, and cook it thus. Now cut a bit of fat off the other, throw this fat on a surface of clear, glowing, flameless coal or coke, and, when a good blaze is thus obtained, immerse this half chop recklessly and unmercifully in *this* flame; there let it splutter and fizz, drop more fat and make more flame, but hold it there, nevertheless, for a few minutes, and then taste the result.

In spite of its blackness, it will be (if just warmed through to the above-named cooking temperature) a deliciously cooked, juicy, nutritious, digestible morsel, apparently raw, but actually more completely cooked than if it had been held twice as long, at double the distance, from the surface of the fire.

For further instruction, make a third experiment by imitating the cautious unscientific cook, who, ignorant of the difference between the condensation products of coal and those from beef and mutton fat, carefully raises the gridiron directly the flame from the dropping fat threatens the object of her solicitude. The result will be an ordinary domestic chop or steak. I apply this adjective, because, in this particular effort of cookery, the grilling of chops and steaks, domestic cookery is commonly at fault. The majority of our city men find that while the joint cooked at home is better than that they usually get at restaurants and hotels, the chops and steaks are inferior.

I believe that this inferiority is due, in the first place, to the want of understanding of the difference between coal-flame and fat-flame; and in the second, to the advantage afforded to the "grill-room" cook by his specially constructed fire, where a large surface of glowing coke is surmounted by a sloping grill, whereon he can expose his chops and steaks to the radiation from a large glowing surface with a minimum of convection heat, the hot air passing in a current over the coke surface having such small depth that it barely touches the bars of the grill. (This may be seen by watching the course of flame produced by the droppings of the fat.) The same obliquity of draught prevents the serious blacking of the meat, which, although harmless, is unsightly and calculated to awaken prejudice.

The high temperature rapidly imparted by radiation to the surface of the meat forms a thin superficial crust of hardened and semi-carbonized albumen and fiber, which resists the outrush of vapor, and produces within a certain degree of high pressure, which probably acts in loosening the fibers. A well-grilled chop or steak is "puffed" out—made thicker in the middle; an ill-cooked, desiccated specimen is shriveled, collapsed, and thinned by the slow departure of its juices.

## IX.

Happy little couples, living in little houses with only one little servant—or, happier still, with no servant—complain of their little joints of meat, which, when roasted, are so dry, as compared with the big,

succulent joints of larger households. A little reflection on the principles applied in my last to the grilling of steaks and chops will explain the source of this little difficulty, and I think show how it may be overcome.

I will here venture upon a little of the mathematics of cookery, as well as its chemistry. While the weight or quantity of material in a joint increases with the cube of its through-measured dimensions, its surface only increases with their square—or, otherwise stated, we do not nearly double or treble the surface of a joint of given form when we double or treble its weight; and, *vice versa*, the less the weight, the greater the surface in proportion to the weight. This is obvious enough when we consider that we can not cut a single lump of anything into halves without exposing or creating two fresh surfaces where no surfaces were exposed before. As the evaporation of the juices is, under given conditions, proportionate to the surface exposed, it is evident that this process of converting the inside middle into two outside surfaces must increase the amount of evaporation that occurs in roasting.

What, then, is the remedy for this? It is twofold: First, to seal up the pores of these additional surfaces as completely as possible; and, secondly, to diminish to the utmost the time of exposure to the dry air. Logically following up these principles, I arrive at a practical formula, which will probably induce certain orthodox cooks to denounce me as a culinary paradoxer. It is this: That *the smaller the joint to be roasted the higher the temperature to which its surface should be exposed.* The roasting of a small joint should, in fact, be conducted in nearly the same manner as the grilling of a chop or steak described in my last. The surface should be crusted or browned—burned, if you please—as speedily as possible, in such wise that the juices within shall be held there under high pressure, and only allowed to escape by burst and splutters, rather than by steady evaporation.

The best way of doing this is a problem to be solved by the practical cook. I only expound the principles, and timidly suggest the mode of applying them. In a metallurgical laboratory, where I am most at home, I could roast a small joint beautifully by suspending it inside a large red-hot steel-melter's crucible, or, better still, in an apparatus called a "muffle," which is a fire-clay tunnel open in front, and so arranged in a suitable furnace as to be easily made red-hot all round. A small joint placed on a dripping-pan and run into this would be equally heated by all-round converging radiation, and exquisitely roasted in the course of about ten to thirty minutes, according to its size. Some such an apparatus has yet to be invented in order that we may learn the flavor and tenderness of a perfectly-roasted small joint of beef or mutton.

For roasting large masses of meat, a different proceeding is neces-

sary. Here we have to contend, not with excessive surface in proportion to bulk—as in the grilling of chops and steaks and the roasting of small joints—but with the contrary—viz., excessive bulk in proportion to surface. If a baron of beef were to be treated according to my prescription for a steak, or for a single wing-rib, or other joint of three to five pounds' weight, it would be charred on its surface long before the heat could reach its center.

A considerable time is here inevitably demanded. Of course, the higher the initial outside temperature, the more rapidly the heat will penetrate ; but we can not apply this law to a lump of meat, as we may to a mass of iron. We may go on heating the outside of the iron to redness, but not so the meat. So long as the surface of the meat remains moist, we can not raise it to a higher temperature than the boiling-point of the liquid that moistens it. Above this, charring commences. A little of such charring, such as occurs to the steak or small joint during the short period of its exposure to the great heat, does no harm ; it simply "browns" the surface ; but if this were continued during the roasting of a large joint, a crust of positively black charcoal would be formed, with ruinous waste and general detriment.

As Rumford proved long ago, liquids are very bad conductors, and when their circulation is prevented by confinement between fibers, as in the meat, the rate at which heat will travel through the humid mass is very slow indeed. As few of my readers are likely to fully estimate the magnitude of this difficulty, I will state a fact that came under my own observation, and at the time surprised me.

About five-and-twenty years ago I was visiting a friend at Warwick during the "mop" or "statute fair"—the annual slave-market of the county. In accordance with the old custom, an ox was roasted whole in the open public market-place. The spitting of the carcass and starting the cookery was a disgusting sight. We are accustomed to see the neatly-cut joints ordinarily brought to the kitchen ; but the handling and impaling of the whole body of a huge beast by half a dozen rough men, while its stiffened limbs were stretching out from its trunk, presented the carnivorous character of our ordinary feeding very grossly indeed.

Nevertheless I watched the process, and dined on some of its result. The fire was lighted before midnight, the rotation of the beast on the horizontal spit before it began shortly after, and continued until the following midday, all this time being necessary for the raising of the inner parts of the flesh to the cooking temperature of about 180° Fahr.

Compare this with the grilling of a steak, which, when well done, is done in a few minutes, or the roasting of the small joint as above within thirty minutes, and you will see that I am justified in dwelling on the great differences of the two processes, and the necessity of very varied proceeding to meet these different conditions.

The difference of time is so great that the smaller relative surface is insufficient to compensate for the evaporation that must occur if the grilling principle, or the pure and simple action of radiant heat, were only made available, as in the above ideal roasting of the small joint.

What, then, is added to this? How is the desiccating difficulty overcome in the large-scale roasting? Simply by *basting*.

All night long and all the next morning men were continuously at work pouring melted fat over the surface of the slowly-rotating carcass of the Warwick ox, skillfully directing a ladleful to any part that indicated undue dryness.

By this device the meat is more or less completely enveloped in a varnish of hot melted fat, which assisted in the communication of heat while it checked the evaporation of the juices. In such roasting the heat is partially communicated by convection through the medium of a fat-bath, as in stewing it is all supplied by a water-bath.

I purpose making an experiment, whereby this principle will be fully carried out. I shall melt a sufficient quantity of mutton-fat to form a bath, in which a small joint of mutton may be immersed, or of beef-fat for beef; and then keep the melted fat at about the cooking temperature, or a little above it—say the boiling-point of water, which will be indicated by the spluttering due to the evaporation of the water in the meat. The result of this experiment will be duly reported to the readers of "Knowledge" when I reach the general subject of frying. In my next I must continue this subject of roasting, which is by no means exhausted yet. Count Rumford devotes seventy pages to it, and I quote his words for my own use. He says: "I shall, no doubt, be criticised by many for dwelling so long on a subject which to them will appear low, vulgar, and trifling; but I must not be deterred by fastidious criticisms from doing all I can do to succeed in what I have undertaken. Were I to treat my subject superficially, my writing would be of no use to anybody, and my labor would be lost; but by investigating it thoroughly I may, perhaps, engage others to pay that attention to it which, from its importance, it deserves." *—*Knowledge.*

## THE GEOLOGICAL DISTRIBUTION OF NORTH AMERICAN FORESTS.

By THOMAS J. HOWELL.

THE causes which have determined the present distribution of the flora of the world have occupied the minds of some of the ablest students of natural history, but no satisfactory solution of the problem has yet appeared. If we accept the theory of Raumer, that plants are

* "Essays Political, Economical, and Philosophical," vol. iii, p. 129.

limited in their northern extension by heat alone, we shall find many anomalies difficult to reconcile, as no isothermal lines limit species. Nor will De Candolle's theory, that the limits are governed by the values of heat which are useful to a plant, assist the student; for climatic causes are not the only ones which limit vegetable species, or we should then find the same species growing in every portion of any isothermal belt of a continent, where the same conditions of heat and moisture exist, which is not the case. Some species, apparently very local in their habits and confined to a very limited area, are found many miles farther north, with no intervening stations. For example: the *Shizæa pusilla*, a little fern, was thought to be peculiar to New Jersey, where it is confined to the pine-barren district, but it has lately been found in Nova Scotia and Newfoundland, while no intervening stations have as yet been reported.

Here we have a plant, capable of propagating itself in New Jersey, which was long thought to be its only home, reappearing several degrees farther north, where the climate is colder and otherwise different, and yet unknown west of the Alleghany Mountains, where the climate is very like that of New Jersey. Neither do we find many of the plants of the western slope of the Alleghanies growing upon the eastern side.

It is well known that if a piece of coniferous forest be cleared of its timber, in Virginia or Pennsylvania, its site will soon be covered with a growth of deciduous trees, but, if then left undisturbed, the coniferous trees of the original growth will finally reassert their supremacy, and in course of time the forest again becomes exclusively coniferous. The black-walnut (*Juglans niger*), which grows naturally from North Carolina to the Great Lakes, and will grow with equal luxuriance on the Pacific coast at latitude 45°, bearing fruit which will germinate if planted, has never yet been known by the writer to grow in Northern Oregon if left to itself. I have examined the walnuts in the spring in Oregon, which fell from the trees the previous fall—they were invariably rotten. Now, as one of the necessary conditions of plant-distribution is the production of seed which will grow unaided by man upon the soil which supports the parent, it follows that there is some other cause than the requisite amount of heat that prevents the black-walnut from becoming naturalized in Oregon.

In the Smithsonian Report for 1858, page 246, is an article by Dr. J. G. Cooper on the "Forests and Trees of North America," accompanied with a map of North America north of Mexico.

This map* is divided into provinces and regions, according to the distribution of forest-trees, and the views herein maintained will be more intelligible to the reader who will refer to it, and compare it with a geological map of the same territory.

* A better map forms the frontispiece to the Agricultural Report of the Patent-Office Report for 1860.

It will perhaps be best to describe the provinces briefly:

The Lacustrine province extends from the Rocky Mountains east to the coast of Labrador, and from the northern limit of trees south to latitude 42° at or near the level of the sea. The line marking the southern boundary curves gradually from west to northwest; commencing at the west end of Lake Erie, on reaching Lake Winnipeg it pursues a northwestern direction to the base of the Rocky Mountains about latitude 60°.

The Appalachian province comprises the Atlantic States south of latitude 43° and east of the border of the prairies; the latter, commencing at the west end of Lake Erie, forms a curve nearly parallel to the Atlantic coast, and ends at the southwest corner of Louisiana.

The Campestrian province commences at latitude 60° in the Rocky Mountains; its northern boundary extends southeast to Lake Erie; its eastern boundary extends from the latter point south to the mouth of the Sabine River. The valley of the Rio Grande forms the southern boundary. The western boundary is formed by the base of the Rocky Mountains, extending northwest from longitude 104° 30′ to latitude 60°.

The Rocky Mountain province embraces the high central mountains from the Campestrian province to the foot-hills of the Cascade and Sierra Nevada Mountains.

The Caurine province begins at the northern limit of trees, on the Pacific coast, and extends east to the western boundaries of the Lacustrine and Campestrian provinces. Its southern boundary begins at latitude 48°, on a southern extension of the western boundary of the Campestrian province, extends northwest to the British line at its junction with the line between Washington and Idaho Territories, thence south to latitude 42°, and then southwest to the Pacific Ocean at latitude 38°.

The Nevadian province lies south of the Caurine, between the Rocky Mountain province and the Pacific Ocean.

The Mexican province lies south of the Rocky Mountain province, between the Campestrian on the east and the Nevadian on the west.

Now, comparing this forest-map with a geological map of the territory embraced, it will be found that the provinces and regions of the former coincide with the geological formations to a remarkable degree.

Beginning with the Lacustrine province it will be found that the formation is mostly granite, or what is popularly known as such, with some beds of Silurian and Devonian; also a few patches of tertiary rocks along the coast. Hence, the three regions comprising this province are really but one; and, accordingly, it has no trees not found south of it in the Alleghany Mountains, which are an extension of the granitic rocks. This province is characterized by its great numbers

of coniferous trees; while some of the trees peculiar to the valleys west of the Alleghanies grow on the Silurian and Devonian beds.

The Appalachian province is composed of all the geological formations of North America, and its regions are very distinct.

The Alleghany region, comprising the eastern slopes of the uplands, and the lower Alleghanies, terminating in a point of latitude 34° in Georgia, is mostly granitic, but has streaks of Silurian and Triassic running through it. We find the same class of trees in it that grow in the Canadian region (Canada), with a few added which are perhaps limited by heat. These, with a few oaks and hickories, which are more prevalent on the Triassic formation than elsewhere, form the bulk of the forest-growth.

The Ohio region, embracing the eastern uplands of the Ohio Valley, east of the prairies and north of latitude 38°, is composed geologically almost wholly of Silurian, Devonian, and carboniferous beds, covered in places with drift from the north. It is marked by its large number of deciduous trees, no other country boasting of so many fine oaks, hickories, and walnuts. It is, however, very poor in coniferæ, and, but for a few stragglers, might be said to have none. Allied species are found to be plentiful in the tertiary formation nearly across the continent, indicating that this class of trees at one time reached from the Alleghanies to the Rocky Mountains, the middle of the belt having been destroyed by the more recent changes of the physical conditions of the earth's surface. As they have never returned since the glacial epoch, the inference is that the conditions of soil and climate have been so changed that the country west of the ninety-seventh degree of longitude is not capable of supporting these trees.

The Tennesseean region is a southwestern continuation of the Ohio region. It is composed of the same geological beds, with a few spurs of the granite ridges of the Alleghanies running into it, and therefore contains more coniferæ than the Ohio region. Still, the bulk of its timber is of the same class of broad-leaved trees that are found north of it, the only differences being such as climate alone makes.

The Carolinian region borders on the Atlantic coast between the Alleghany Mountains and the ocean from Middle Georgia to Long Island. It is composed of cretaceous and tertiary beds, with a strip of Triassic along the western edge. In the northern portion are some beds of drift of granite from the north. Here we have a distinct class of coniferæ on the cretaceous beds that are peculiar to this region, and another class on the drift that are also found growing farther north. Arthur Hollick,* who has made observations on the flora of Staten Island, says: "We have on Staten Island two well-marked geological formations: the *drift*, which covers about two thirds of the entire island, nearly all of the northern part, and extending as far

* "Bulletin of the Torrey Botanical Club," vol. vii, p. 14.

south as Prince's Bay; and the *cretaceous*, which occupies the remaining small area in the southern and western part. This latter is a continuation of the New Jersey clay-beds. The geological line of separation between the two formations is not always very distinct, but the limits of the different species of plants mark it in unmistakable characters. The two floras are remarkably distinct. That one belonging to the cretaceous is well represented by *Arctostaphylos, Uva-ursi, Aster concolor, Pinus inops, Quercus Phellos, Quercus nigra, Lycopodium inundatum, var. Bigelowii*, and many more of the pine-barren plants. Thus far I have never found any of these species to have crossed the line of the drift, but in their stead will be found *Pinus nigra, Quercus alba, Quercus rubra*, etc., and the majority of those plants which grow in the vicinity of New York Island and up the Hudson."

The Mississippi region embraces the lowlands bordering the Gulf of Mexico from Middle Georgia to Texas, and extending up the Mississippi and its branches to latitude 30°. It is a continuation of the Carolinian region, its characteristic trees growing from the Gulf of Mexico to the coast of Maine. It is composed of the same tertiary and cretaceous beds of the Carolinian region, with a few patches of alluvial deposit along the coast.

The Florida region is well marked and peculiar, being entirely coral alluvial. It has the peculiar flora of that formation found all over the world. Some of its plants are found farther north; but small beds of alluvial are not uncommon along the coast as far north as New Jersey.

The Campestrian province might be considered as one region, but Cooper* has divided it into five. The Saskatchewan region, embracing all north of latitude 49°, together with the basin of the Red River of the North, has some spurs of the Canadian region running into it, and consequently some of the Canadian species are found on them and on the adjacent Silurian and other formations. This region has no characteristic trees of its own. The Illinois region lies between latitudes 46° and 38°, running west to longitude 101°; on the east it is bounded by the forest provinces. It is a continuation of the Ohio region, being underlaid with the same beds of Silurian and carboniferous deposits, with cretaceous and tertiary beds on the west. But here a new feature enters into the geological characteristics. The loess or lacustrine deposits which cover the whole province from four to one hundred and fifty feet, though devoid of trees, have a peculiar flora, composed largely of compositæ, and being one of the latest of geological deposits, they furnish the most recent botanical species of the compositæ. None of the compositæ have yet been found in any of the fossil flora; hence it has clearly appeared upon the earth since the Tertiary period. Another remarkable fact is that on the eastern side of the Illinois region where

* "Patent-Office Report" (Agriculture), 1860, p. 424.

the loess-beds are not very thick, and, therefore easily cut through by streams, wherever they are thus eroded, we find dense groves of oak, walnut, hickory, and other trees characteristic of the Ohio region. With these exceptions however, the whole region is prairie; hence it would seem that the loess is not capable of sustaining forest-growths for any length of time, for it evidently was timbered during the time that part of it was covered by lakes and marshes. But when the great rivers cut their beds down to nearly their present level, the timber gradually died out; not being burned, as some suppose, but disappearing because the geological formation will not retain moisture enough to sustain forest-growth.

The Texan region, lying south of the Illinois region, and extending west to 101° of longitude on the Rio Grande, is a continuation of the Mississippi region, and is underlaid with cretaceous and tertiary deposits. It is covered in many places with loess. It, therefore, has the characteristic trees of the Mississippi region wherever trees grow, and the characteristic loess flora on the prairies.

The Comanche region, lying south, and the Dakota region, north of latitude 38°, are nearly destitute of timber. The former is underlaid with triassic and the latter with cretaceous and tertiary beds; but they are covered with loess from ten to one hundred feet or more, and hence the loess flora predominates.

The mountain-region of the Rocky Mountain province is composed of granite, but has enough trachyte and other volcanic rocks to modify its flora to some extent. It also has some beds of Silurian on the eastern border, and here, strongly corroborating our views, we find some of the Eastern flora mixed with the Western and Southwestern that lie next to it. Its valleys and parks are covered with loess, and are treeless.

The Saline region, comprising the remainder of this province, is underlaid with tertiary of a different epoch from that of the Atlantic coast, but is covered with heavy beds of basalt in many places. This basalt is covered with a deposit analogous to the loess, and is treeless, but has a flora very similar to that of the Dakota region. The tertiary has a flora of its own, generally known as the sage-brush (*Artemisia*) flora, being composed of a number of shrubs peculiar to this region.

The Caurine province is composed of basaltic rocks principally, but has some tertiary beds, and the higher mountains are granitic at their tops. As the rocks are of an entirely different character from those of the Atlantic side of the continent, we should not be surprised at finding an entirely different flora. In fact, none of the Eastern trees reach this province, nor do any of its trees appear farther east than the Rocky Mountains. The geological formation of this province being mostly basaltic, the trees are characteristic of that formation, for the tertiary beds, wherever they are of sufficient size to make an

impression on the flora, are all prairie, with scattered groves of oak (*Quercus gargana*), and this of but one species. The *Abies Douglasii*, *Pinus ponderosa*, and *Thuga gigantea*, are samples of this flora, for I have never seen any of them growing on any land that was not made from the disintegration of basaltic rocks.

The Nevadian province is composed of nearly all the geological formations common to North America, and, in accordance with our views, it has a flora of corresponding variety. Nearly all the genera of Eastern forests are represented, though different species are common. It has some very local trees, no doubt confined to geological formations of a peculiar character. Of these are the two *Sequoiæ*—the redwood and the "big tree." The former is confined to a narrow strip along the coast, the latter to the tops of the high mountains in isolated groves. Exact data are wanting, but it appears from the geological maps at the writer's command that the redwood is confined to the cretaceous formation which extends from about latitude 34° to 40°. As this is about the range of the redwood-groves, it will probably be proved, on close investigation, that this tree is confined to the above formation.

The *Sequoiæ* have a peculiar interest for the students of natural history, being the only living representatives of a once large and widely-distributed genus now found in the tertiary beds from British Columbia to California, and east to Nebraska. It appears to have been nearly exterminated about the glacial epoch, and is now confined to small localities that appear not to have been covered by the ice at that time.

In the foregoing pages I have made use only of trees to illustrate the affinity of plants for certain geological strata, but, should I have taken the general flora, the argument would appear still more convincing. To do this, however, it would have been necessary to divide the country into smaller regions, and to have given the geological characters more in detail than is at present practicable.

Were other proofs wanting to demonstrate the intimate relations existing between geological formations and the geographical distribution of the flora, they are close at hand in the writings of our eminent botanists. Sir Joseph D. Hooker, in a lecture on the distribution of the North American flora,* treats the subject upon the theory that all plants originated from small centers of creation and spread by slow encroachment upon the adjacent territory as fast as this was in a condition to receive them, and that climatic influences alone limit their extension. He makes four general floral regions:

"1. The great Eastern forest-region, extending over half the continent, and consisting of mixed deciduous and evergreen trees, reaches from the Atlantic to beyond the Mississippi, dwindling away as it ascends the western feeders of that river on the prairies. It is noteworthy for the number of kinds, especially of deciduous trees and

* "American Naturalist," xiii, 155.

shrubs, to be found in it. . . . 2. The prairie-region succeeds ; a grassy land, with many peculiar herbaceous American genera, including Mexican types, of which last the most conspicuous are a yucca and the cacti, which latter increase in number as the Rocky Mountains are approached, where they form a noticeable feature in the landscape. In the parks and lower valleys of the Rocky Mountains, deciduous trees are few and scattered, and the forest is an open one of conifers. . . . Higher on the mountains the coniferous forests are dense. . . . 3. Descending to the sink-region, . . . deciduous trees are very few and confined to the gullies of the mountains. . . . The hardy sage-brush (*Artemisia*) covers immense tracts of dry soil, and saline plants occupy the more humid districts. 4. The Sierra Nevada is clothed with the most gigantic coniferous forests to be found on the globe, among which a very few species of deciduous trees are scattered ; but none of these are identical with trees of the Eastern forests."

Applying the geological charts to these four general floral regions, we find corresponding to each of them respectively : 1. The great Silurian and carboniferous beds, with their large varieties of deciduous trees, the Alleghanies on the east, with their coniferous plants, and the loess-beds on the west, with their peculiar prairie flora, and a few trees along the streams. 2. The deeper loess-beds with a peculiar flora, and the Rocky Mountains with their mixed geological characters, mainly volcanic, and with a mixed flora of Eastern and Western trees, the latter predominating. 3. The tertiary beds of the saline region, which are different from those of the East, with their peculiar sage-brush and saline flora. 4. The Sierra Nevada region, with mixed geological characters of gneiss and lava, and a mixed Mexican and Northwest flora.

Thus, from more than one point of view, the North American flora is susceptible of being divided into three or more distinct floras, corresponding to the different geological formations which they inhabit.

## PERRIER ON THE THEORY OF DESCENT.

By M. A. ESPINAS.

THE preface of twenty pages with which M. Edmond Perrier has introduced M. Levêque's French translation of Mr. Darwin's essay on "Earth-Worms" is a masterly work, the importance of which will escape no one. We know that this eminent naturalist, after having given a quite cool reception to the theory of descent, at last, in his "Colonies Animales," accepted it, under reserves, the tendency of which was to restrict the bearing of evolution at different points. First, he denied that that theory could explain the passage from the

inorganic to the organic. Secondly, he refused to account, by it alone, that is, by the combined action of the environment and of heredity, for living forms; but had recourse, to explain some among them, to an internal *nisus*, or an original preformation analogous to final causes. Lastly, he believed that the general laws of evolution expired in some way at the threshold of the human world, and that human consciousness is formed after other laws than the organic consensus. It was the part of philosophy, now in possession of an idea of science which it owes largely to the scientific men themselves, to indicate these later reserves. For it is, after all, no small matter to know what is of science and what is not. It is imperatively necessary for us to fix our eyes on this capital point, and to decide among ourselves whether those who in their researches accord a part to final causes, and attribute an exceptional position in nature to man, are performing a work of science or of metaphysics. This is why, without losing sight of the rare merits of the work we have named, we have thought it proper to point out the ambiguous character of some parts of it.

Now, M. Perrier has resolutely canceled most of his reserves. The second part of his preface, in which he for the first time traces the geographical distribution of the species of terrestrial lumbrici, and points out the consequences of such distribution both in respect to specific characteristics and from the geological point of view, is out of our province to consider. The first part, which is devoted to a general appreciation of Darwin's work, has a high philosophical significance; and we here give a summary of the whole of it.

"Until within the last twenty years," says the author, "living beings were nearly always studied independently of the medium in which they live and of the relations which they form with each other. Each of them appeared to be a distinct entity, owing nothing except to itself, capable of abstracting itself from every modifying action on the part of external agents, created once for all in view of certain conditions of existence, marvelously adapted to these conditions, but unable to extricate itself from them except at the cost of perishing, in perfect equilibrium with the supposed unchangeable medium, but destined to disappear whenever the equilibrium was broken. This false conception of the living being has caused the failure of every essay at a philosophy of the natural sciences which has been attempted till now."

M. Perrier then shows by a small number of selected examples that each being, under the pressure of variable circumstances is, aside from any preconceived plan, adapted to its environment, even when it may not have seemed primarily destined to live in it; some fishes to a life in the air, some mammals and some birds to an aquatic life. He remarks that the living beings of the environment are the preponderant part of the medium for each species. Adaptations not less close than those which unite organisms to the physical medium, put organisms in

dependence, one upon another, and provoke morphological variations which wholly change the aspect of each one of them. "The probosces of bees and of butterflies would be useless to them if there existed no flowers." The teeth of mammals tell what their regimen is. All their structure is likewise derived and by a kind of reaction from it. "The tongue of the ant-bear and its enormous salivary glands can evidently be useful only for the capture of ants, termites, and other insects living in societies. There are insects that never come out of the ant-hills; some of them are blind, and others can not eat anything but the food with which the ants gorge them." Innumerable parasites have been modified in a similar manner by the animal environment accidentally chosen by them; and all, starting from very different points, have, under the empire of analogous conditions of existence, put on similar characters. It is Darwin's glory to have established that while the physical and organic mediums are incessantly changing and endlessly producing the most varied and most unforeseen conditions, there are none among them to which organisms have not been able to bend themselves with a flexibility almost without limits.

These relations of the being with its medium furnished "the most powerful arguments for the doctrine of final causes. For this doctrine will hereafter be substituted a higher, a broader philosophy, a conception of the living world which will be wonderful only by its majestic simplicity. Every adaptation of a living being to a determined mode of existence has become no longer only a marvel to admire, but is also a problem to be resolved. This study, in fact, is that of the whole of natural history."

At this point is given a brilliant picture, in which, reviewing the great divisions of the animal kingdom, the author designates in each of the dominant forms of living beings the effect of the conditions of their existence. Every type, we may say, is thus formed by these conditions. To them must be attributed not only the variations in detail which only are commonly called adaptations, but the essential traits of the type, "due also to an anterior adaptation, the effects of which have been transmitted from more or less remote ancestors to their posterity." It results from this that the characteristics proceeding from the most ancient adaptations should be and are the most widely spread. And, as it is precisely the degree of generality of a characteristic which gives it its methodical value (the most general have been called dominant by Cuvier), their order of subordination is simply their order of antiquity. "The classifications, of which the dryness was formerly legendary, thus become all-palpitating with historical interest," for they relate to us the series of conditions of which the animal kingdom is the work and the witness.

Must man be excepted from the general operation of these laws? In no way. It is from the natural sciences thus renovated that we must demand, says M. Perrier, "an exact and scientific notion of the

place of man in nature." Whatever emotion the application of the doctrine of evolution to the moral world may cause, and however grave may be the shock it inflicts on the edifice of beliefs, it should be accepted with confidence, for it is true, and the truth can not be wrong. Even if it exacts a transformation of the social order by transforming beliefs, it must be faced resolutely. The natural sciences thus impose themselves on the attention even of the statesman. "It is necessary attentively to follow their progress, to measure the bearing of their discoveries, to study their actual or possible influence on current beliefs and ideas, and to endeavor to construct a new edifice all the more quickly as the bases of the old one appear to be seriously threatened.

These declarations deserve a hearing. They have a considerable importance, not only because they come from a naturalist whose works* and position assure him one of the first places among the French scientific men of his generation, but also and especially because this naturalist is not suspected of any inconsiderate enthusiasm for the doctrine of evolution, and because he only yesterday was defending the beliefs we have spoken of against it. The honorable scruples which have kept him back seem at last to have yielded to the force of accumulated proofs: he lets fall the barriers which he seemed disposed to keep up between nature and man; he perceives that mechanism and science blend, and does not hesitate to say so. We expected nothing less from his clear-sightedness and his sincerity.—*Translated for the Popular Science Monthly from the Revue Philosophique.*

## OUR INDIAN MYTHOLOGY.

By J. HENRY GEST.

THE myths of a people are the first crude embodiments of its religious feeling. They are first formulated in stories told over the fires of long winter evenings, and pass on as traditions from father to son, until written language at last makes a record of them. How carefully European students have gathered them together, seeking to extract from the scanty records the hidden image which inspired them! Any reader of this can recall some myth of Greece, or Rome, or early Europe; but how many are aware that here, among our own Indians, there exists a mythology from which not a little can be learned of the religious feeling of a rude civilization such as our own Aryan ancestors passed through long centuries ago?

Among recent German publications is a small pamphlet of seventy

* One of these works, a study of the organization of worms, has been pronounced "admirable" by Mr. Darwin.

pages, in which Mr. Karl Knortz, under the title "Mythology and Civilization of the North American Indians," gives the impression made on him during a visit among the Indians. Having read such books as we have on the subject, he has selected and briefly sketched a few of the myths, drawing some deductions from them. In the second part of the pamphlet he takes a rather favorable view of the prospect of civilization among the remaining tribes. It will be a pity if the book is not translated, as its pleasant style would make it popular reading among many who are not capable of taking it in the present form. We call attention to this book as an indication that the subject is receiving the attention abroad which it should have at home.

In what follows, an attempt is made to indicate a direction in which the Indian myths throw light on early religion. There is nothing new in the view taken, though it is one which has not yet received sufficient consideration.

The civilization of Europe to-day is generally accepted as the result of passing through three stages of social growth:

First, that of hunters, wandering over the country in search of animal food for daily sustenance.

Second, that of nomadic shepherds, moving about from pasture to pasture with herds of domesticated animals, which supply food and clothing more regularly and with less hardship than does the hunt.

Third, the stage of agriculture, when the plow anchors man to the spot of chosen land. Out of this has grown, after a long and tedious struggle, our complicated commercial civilization.

The Indian belongs to the first of these stages, and in attempting to civilize him we are trying to raise him to the third, without his having passed through the second. To say the least, it is extremely doubtful if even our assistance can accomplish a result which Nature has denied everywhere else. However, to return, the Indian myths are those of a hunter; and the Aryan was once, long, long ago, a hunter. This point of contact is what gives the myths their principal interest. They preserve the religious feeling of what is considered the earliest civilization, and are, therefore, valuable to a student of the progressive growth of religion; and this, however different anthropology and physiology may show the Aryan and Indian.

In all religions there are two great omnipresent relations—of man to nature, to God, and of man to man. One is the worship side, the other the moral side. Confining ourselves to the relation of man to nature, what has the study of early Aryan myths shown to be man's first conception of the nature around him? The Hindoos have probably wandered less over the face of the earth, and suffered less, than any other Aryan people. Their early religious records are consequently the clearest and the best preserved. From these it appears that the earliest religion was what is now called animisn. This is, as you choose, the soul, ghost, or spirit theory of nature; and is sup-

posed to have had its source in dreams, the impalpable nature of whose visions suggested the presence in the dreamer of a soul distinct from the body. If the presence of a soul could explain dreams, it could equally well be made to explain such things in himself as man could not rationally comprehend. The idea of his own soul is followed by the idea of a soul in every man. From this it is but a short step to the idea of a soul or spirit in nature, to account for mysterious powers and properties. Thunder and lightning become the work of a spirit; fire, heat, and cold, the presence of others; and so on through all nature. Wherever there is something inexplainable, there is a mysterious spirit.

This is the earliest and simplest animism. Soon, however, unequal forces of nature suggest unequal spirits behind and in them, and gradually great and small spirits develop, some predominating others. Throughout, all, whether equal, great, or small, are worshiped on account of their mysterious powers. Besides the spirits in living bodies and in nature, are the souls released by death, but imagined still to wander at times about the earth, and to have some influence on living men, especially in controlling the fate of their bodily descendants. From this conception arose ancestral worship, and the many ceremonies at the grave intended to give peaceful rest beyond, that the departed spirit might thus be kindly disposed toward his offspring. A belief in a future life was necessary to a strong, active people having a tenacious love of life.

Little by little, as man becomes more self-appreciating, more confident in his superiority in the midst of surrounding nature, he gives to each great and small spirit a personality more or less like his own. Some of these will be merely exaggerated men, others a combination of man and animal. But the result of the whole will be that out of animism has grown polytheism, of which all know the congruous enormities in European mythology.

We have now gone as far as necessary in early Aryan religious growth, for a comparison of Indian religion to be made with it.

The Indian myths are a tangle of animism and polytheism, and only when we approach them with the information gained from the study of early Aryan religious worship do the hitherto senseless crudities open their hidden meanings. A few instances will show the animist or spiritual character. When the Algonquin Indian meets something he can not understand, there he fancies a *manito* present. This word has the several meanings of spirit, soul, and the first. The mysterious steel of the white man is *manito-biwabwik*, i. e., spirit-stone. The strange woven cloth is *manito-wegin*, spirit-skin. Among the Chippewas *manitowis* designates the magician. For this same idea of magic, mystery, spirit, soul, the Dakota has the word *wakan*. *Wakan-tauka* is the Great Spirit; *wakan-hdi* the lightning, literally the thing of spirit origin, *hdi* meaning *come*. Thus every mystery is *wa-*

*kan.* "He looks at sun, moon, and stars, but knows not who made them, or of what they are composed; he hears the winds, but, as their nature and source are to him unknown, they are *wakan.*"

To the Indian, wind and his own breath are of all nature most like his conception of the spirit force, and so these are regarded as symbols, even as embodiments, of the spirit. The principal Creek god is "the Lord of Breath"; of the Cherokees, "The oldest of the winds"; of the Choctaws, simply "storm-wind."

Like the Aryans, the Indians believe in immortality, and perform elaborate ceremonies for the benefit of departed souls.

Not content with souls and spirits in themselves and in the forces of nature, they give them also to animals; so that in the dog companion is often the guardian spirit of the Indian.

As you have already noticed, there are spirits of unequal rank and unequal powers in the Indian animism, but, though a principal spirit is at times found, yet there is no idea of a single all-powerful spirit from which all others come!

Now for some examples of the Indian polytheism. Compare the following story with some myths of early Europe. It is given in the words of Mr. Knortz: "When the world still lay in darkness, say the Mixtecas, there appeared a god, 'lion-serpent' by name, and a goddess, 'tiger-serpent.' They went to live on a high mountain, where two sons were born to them, one of whom they named 'Wind of the Nine Serpents,' and the other, 'Wind of the Nine Caves.' When the elder of these wanted amusement, he assumed the form of an eagle and flew about in the world; but the other changed himself to a winged serpent, in which shape he could fly not only through the air, but also through rocks and mountains." How nearly is this play of fancy like that which in dark Europe created dragons for the fabled knights.

The Algonquins have a hero-god, Menabuscho, whose remarkable adventures Mr. Knortz recounts at some length. Among others is an incident of the mysterious value of dragon-oil, which we have learned in the Siegfried myth: "Then he (Menabuscho) set out to war against the great chief Pearl-feather, who had slain his grandfather. He shot the serpent standing guard, and with the oil of the royal beast greased his boat, so that without stopping it ran through the fatal sea of misfortune." After death it became the privilege of Menabuscho to lead the souls of Indians into paradise.

There are numerous myths of the creation of the world and of man; others of a deluge from which only a single pair, man and woman, escaped.

These few examples give but an incomplete and very inadequate presentation of Indian mythology. But they are sufficient to show the presence of animism, and add another straw to the already accumulated evidence that animism is the first definite shape which religious feeling takes.

# LOCUSTS AS FOOD FOR MAN.

By DAVID ALEXANDER LYLE, U. S. A.

THIS subject may appear to some, if not all of you, a rather peculiar one. The eating of insect-flesh is entirely repugnant to our feelings, and at once arouses all our natural and inherited antipathies. Even those who accept literally the Mosaic history of the creation as set forth in the book of Genesis, are loath to take advantage of the permissory bill of fare granted by Divine authority in the book of Leviticus. In the eleventh chapter of Leviticus, verses 1, 21, and 22, will be found these words:

1. "And the Lord spake unto Moses and to Aaron, saying unto them: . . .

21. "Yet these may ye eat, of every flying creeping thing that goeth upon all four, which have legs above their feet, to leap withal upon the earth;

22. "Even these of them ye may eat; the locust after his kind, and the bald locust after his kind, and the beetle after his kind, and the grasshopper after his kind."

Other references may be found in the Bible to the use of locusts as food. In one place in particular, in Mark i, 6, we read that "John was clothed with camel's hair, and with a girdle of a skin about his loins; and he did eat locusts and wild honey."

From these passages we learn that in olden times locusts were considered to be an article of food. And wild honey, which is an insect product, is highly prized by both aboriginal and civilized communities even to this day. In no one particular are we so much the creatures of custom and habit as in eating. That which is a delicacy to one is disgusting to another. The food relished by one nation or tribe may be spurned by another as loathsome. The inhabitants of the interior and mountains are often nauseated by the toothsome dishes of the denizens of the coast. A knowledge of the habits of certain animals (I use the term "animals" in its biological sense as distinguished from plants) often gives rise to an unconquerable abhorrence of the use of their flesh as food. To show how empirical are man's standards of edibles, it will only be necessary to cite a few instances. Beef, for example, is an almost universal article of food. But, should I place before my readers a roast of beef and tell them that this meat was taken from an animal that was accidentally drowned yesterday, my guests would very likely be indignant as well as disgusted, while at the same sitting they would eat and praise the flavor of a fish caught upon the same date and then left to *drown* in the air, if I may use the term, while it flops about and writhes with all the intensity of agony of which its low nervous organization is capable. We dote

upon lobsters and lobster-salad, while a shudder of horrible disgust runs through our frames at the idea of eating a buzzard or a hyena. Yet the lobster is the scavenger of the sea as truly as the others perform the same functions upon the land.

We love the speckled beauties that haunt the mountain-streams, feeding upon insects and worms, while the Apache Mojave Indian turn in scorn from such a dish. The same Indians will regale themselves with the blood that flows from the death-wound they have just inflicted upon a deer, and will eat with relish the liver, smaller intestines, etc., while yet warm, and with little or no preparation; but we could hardly be induced to imitate their example.

Nothing can be more omnivorous and filthy in their feeding habits than chickens and swine; yet we relish the flesh of both with zest. Tripe, liver, and kidneys are esteemed by us, though a knowledge of their functions might cause a tremor of squeamishness to thrill through our bodies. As epicures we eat the diseased livers of geese, insect-eating frogs, small birds and game in an advanced stage of decomposition, and call them delicious as we discourse upon their "gamy" flavor, and at the same time we would not entertain for a moment the idea of eating a dish of freshly-roasted locusts which have fed upon the clean, juicy herbage of our fields. The Hebrews of North Africa eat boiled and fried locusts with avidity, while their co-religionists in this country turn from lobsters with scornful loathing.

The Arab relishes the savory dishes made from locusts, while he expresses his abhorrence of our habit of eating raw oysters. Our society belles shriek with horror and fright at the appearance of a cockroach, yet they sip with pleasure the sherry and madeira wines that are aged, mellowed, and flavored with these pests.

Professor Charles V. Riley, for a long time State Entomologist of Missouri, and now Entomologist at the United States Agricultural Department at Washington, undertook in 1875 a series of experiments "to demonstrate the availability of locusts as food for man, and their value as such whenever, as not infrequently happens, they deprive him of all other sources of nourishment." Professor Riley took a lot of locusts to an hotel to be cooked, but he endeavored in vain to obtain assistance from the monarchs of the gridiron. The cooks and servants retired in disgust, and left the naturalists to do their own cooking. The savory messes that the latter concocted converted the kitchen; cooks and guests alike agreeing that the soups, fricassees, and fritters, composed materially of locusts, were excellent. In regard to these experiments Professor Riley says:

"It had long been a desire with me to test the value of this species (*spretus*) as food, and I did not lose the opportunity to gratify that desire which the recent locust invasions into some of the Mississippi Valley States afforded. I knew well enough that the attempt would provoke to ridicule and mirth, or even disgust, the vast ma-

jority of our people, unaccustomed to anything of the sort, and associating with the word 'insect' or 'bug,' everything horrid and repulsive. Yet I was governed by weightier reasons than mere curiosity; for many a family in Kansas and Nebraska was, in 1874, brought to the brink of the grave by sheer lack of food, while the St. Louis papers reported cases of actual death from starvation in some sections of Missouri, where the insects abounded and ate up every green thing, in the spring of 1875.

"Whenever the occasion presented, I partook of locusts prepared in different ways, and one day I ate of no other kind of food, and must have consumed, in one way or another, the substance of several thousand half-grown locusts. Commencing the experiments with some misgivings, and fully expecting to have to overcome disagreeable flavor, I was soon agreeably surprised to find that the insects were quite palatable in whatever way prepared. The flavor of the raw locust is most strong and disagreeable, but that of the cooked insect is agreeable and sufficiently mild to be easily neutralized by anything with which they may be mixed, and to admit of easy disguise, according to taste or fancy. But the great point I would make in their favor is that they need no elaborate preparation or seasoning, and that they really require no disguise; and herein lies their value in exceptional emergencies, for, when people are driven to the point of starvation by these ravenous pests, it follows that all other food is scarce or unattainable. A broth, made by boiling the unfledged *calopteni* for two hours in the proper quantity of water, and seasoned with nothing but pepper and salt, is quite palatable and scarcely to be distinguished from beef-broth, though it has a slight flavor peculiar to it and not easy to be described. The addition of a little butter improves it, and the flavor can, of course, be modified with mint, sage, and other spices *ad libitum*. Fried or roasted in nothing but their own oil, with the addition of a little salt, they are by no means unpleasant eating, and have quite a nutty flavor. In fact, it is a flavor, like most peculiar and not unpleasant flavors, that one can soon learn to get fond of. Prepared in this manner, ground and compressed, they would doubtless keep for a long time. Yet their consumption in large quantities in this form would not, I think, prove as wholesome as when made into soup or broth, for I found the chitinous covering and corneous parts, especially the spines on the tibiæ, dry and chippy, and somewhat irritating to the throat. This objection would not apply with the same force to the mature individuals, especially of the larger species, where the heads, legs, and wings are carefully separated before cooking; and, in fact, some of the mature insects prepared in this way, then boiled, and afterward stewed with a few vegetables, and a little butter, pepper, salt, and vinegar, made an excellent fricassee. . . .

"I sent a bushel of scalded insects to Mr. John Bonnet, one of the oldest and best-known caterers of St. Louis. Master of the mys-

teries of the *cuisine*, he made a soup which was really delicious, and was so pronounced by dozens of prominent St. Louisians who tried it. Shaw, in his 'Travels in Barbary' (Oxford, England, 1738), in which two pages are devoted to a description of the ravages of locusts, mentions that they are sprinkled with salt and fried, when they taste like crawfish; and Mr. Bonnet declared that this locust-soup reminded him of nothing so much as crawfish *bisque*, which is so highly esteemed by connoisseurs. He also declared that he would gladly have it on his bill of fare every day if he could only get the insects.

"His method of preparation was to boil on a brisk fire, having previously seasoned them with salt, pepper, and grated nutmeg, the whole being occasionally stirred. When cooked, they are pounded in a mortar with bread fried brown, or *purée* of rice. They are then replaced in the saucepan and thickened to a broth by placing on the warm part of the stove, but not allowed to boil. For use, the broth is passed through a strainer and a few *croutons* are added. I carried a small box of fried ones to Europe, where they were tasted by numerous persons, including members of the London Entomological Society and of the Société Entomologique de France. Without exception, they were pronounced far better than was expected, and those fried in their own oil, with a little salt, remained good and fresh for several months; others fried in butter became slightly rancid, a fault of the butter. Mr. C. Horne, F. Z. S., writing to 'Science Gossip,' says: 'In the evening I had asked two gentlemen to dinner, and gave them a curry and croquette of locusts. They passed for Cabool shrimps, which in flavor they very much resembled; but the cook having inadvertently left a hind-leg in a croquette, they were found out, to the infinite disgust of one of the party and the amusement of the other.' . . .

"Locusts will hardly come into general use for food, except where they are annually abundant; and our Western farmers, who occasionally suffer from them, will not easily be brought to a due appreciation of them for this purpose. Prejudiced against them, fighting to overcome them, killing them in large quantities, until the stench from their decomposing bodies becomes at times most offensive, they find little that is attractive in the pests.

"For these reasons, as long as other food is attainable, the locust will be apt to be rejected by most persons. Yet the fact remains that they do make very good food. When freshly caught in large quantities, the mangled mass presents a not very appetizing appearance, and emits a strong and not overpleasant odor; but, rinsed and scalded, they turn a brownish red, look much more inviting, and give no disagreeable smell."

That locusts have been used as food from remote antiquity is well attested by historical writers. As stated before, they are classed among the "clean meats" in Leviticus (xi, 22), and are referred to in other parts of the Bible as human food. One of the Nineveh

sculptures deposited in the British Museum represents men carrying different kinds of meat to some festival, and among them some carrying long sticks, to which locusts are tied, thus showing that they were of sufficient importance to form part of a public feast.

Locusts have been, and are yet, extensively employed as an article of food in parts of Europe, Asia, and Africa. The Romans are said to have roasted them to a bright golden yellow before eating them; and in Russia they are salted or smoked like herrings. Pliny says that locusts were highly esteemed by the Parthians; Herodotus speaks of a tribe of Ethiopians that fed on locusts; and the records of their use in ancient times as food, in both Southern Europe and Asia, are abundant. At the present day this use still continues.

Riley, in his narrative,* says: "Locusts are esteemed very good food by the Moors, Arabs, and Jews, in Barbary, who catch large numbers of them in their season, and throw them, while jumping alive, into a pan of boiling *argan* oil; here they hiss and fry until their wings are burned off, and their bodies are sufficiently cooked, when they are poured out and eaten. I have seen many thousands cooked in this manner, and have had the curiosity to taste them; they resemble, in consistence and flavor, the yolks of hard-boiled eggs."

The Riff Arabs, when they see a swarm of locusts hovering in the air and clouding the sky, watch them with anxiety, and when they descend near their habitations they receive them with shouts of gratitude to God and Mohammed, throw themselves on the ground, and collect them as fast as possible. The locusts, deprived of their heads, legs, and wings, are well boiled in butter, and served up with a substance called *alcuzcuz*. The Riff Arabs consider them delicious food. Their camels also eat them greedily. The Moors use them to this day, by first boiling and then frying them. The Moorish Jews, more provident than their Mussulman neighbors, salt them and keep them for making a dish called *dafina* which forms the Saturday's dinner of the Jewish inhabitants. This dish is made by putting meat, fish, eggs, tomatoes, locusts, "in fact, almost anything edible, into a jar, placing the latter in an oven on Friday night, and then taking it out hot on the Sabbath." In this manner the orthodox Hebrew gets a hot dinner without committing the sin of lighting a fire upon that day.

The Indians of California and the Great Basin also collect locusts for food. The Digger Indians roast them and grind or pound them into a sort of flour, which they mix with pounded acorns, the nuts of the piñon-pine, or with berries. This mixture they make into cakes and dry in the sun for future use.

Among the other uses to which locusts are applied is fish-bait for the sardine-fisheries off the coast of Spain; and similar bait might be

* Published in 1859.

prepared by the Western farmers for use upon the Atlantic and Pacific fishing-grounds. A very important chemical substance used in the arts may be extracted from locusts by the action of sulphuric acid. This is formic acid, for which many applications have been found in therapeutics and in the laboratory. By collecting, killing, and burying them in trenches, or in compost-heaps, these insects might be utilized as fertilizing agents, or they might be collected in large quantities, dried, and sent East in bales as food for poultry.

Although the writer does not profess to be an advocate of entomophagy, nor does he intend to become an acridophagist himself, unless absolutely necessary, yet he believes, with Professor Riley, that, when the devastations of the Rocky Mountain locusts lay waste our Western domain, the inhabitants of these regions need not die for want of food so long as a supply of locusts exists. Persons should not allow prejudice and squeamishness to stand in the way of self-preservation.

## A NATURAL SEA-WALL.

By LOUIS BELL.

ALONG the New Hampshire sea-coast, in the towns of Rye and North Hampton, stretches a curious and massive formation, which at first sight appears as if built at enormous expenditure of time and labor. On closer examination, however, it proves to be only one of Ocean's eccentric freaks, executed in this case with almost human intelligence and care.

A sea-wall, compactly formed of water-worn pebbles of all sizes, shapes, and materials, runs along the beach for about six miles, here and there broken by rocky points and little inlets, somewhat modified by its situation, but preserving with astonishing regularity several remarkable features. In places it is so high and wide that one can hardly believe it anything but a carefully constructed dike, designed to shelter the adjoining fields. Along part of its extent, where it separates the ocean from an extensive salt-marsh, it is utilized by the farmers of the neighborhood for a cart-road. Along another stretch, a plank-walk surmounts it for half a mile.

It first appears in the form of a low wall composed of three terraces, near Little Boar's Head, in the town of North Hampton, thirty rods south of the slight projection known on the charts as Fox Hill Point. This portion of the wall is only about twenty rods in length, and seems much like a stone facing to the steep beachward slope. Some forty rods north of the point it reappears, this time in the form of a large and compact dike, and extends along the water-line in a crescent form for at least fifty rods, terminating at a small cove directly east of

the well-known Farragut House. This section of the wall is by far the most symmetrical and characteristic, and is the one selected for a more detailed examination and description. Beyond this point the wall runs with occasional breaks to its northern terminus without presenting any novel features.

The annexed diagram, enlarged from measurements by the United States Coast Survey, shows that part of the wall between Fox Hill

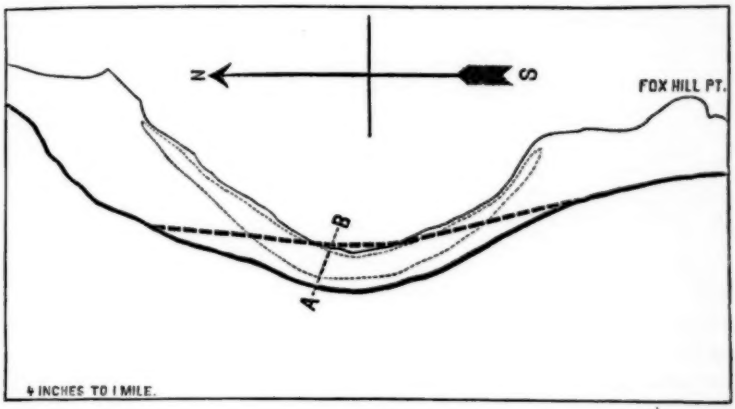



FIG. 1.

Point and the Farragut House. It has the form of a shallow crescent, and follows high-water mark quite closely, just east of the highway. It has the general peculiarities very strongly marked, but near its northern extremity is so modified by an adjacent shoal as to give an easily-followed clew to the method of its formation. It has the three neat terraces common to the whole of the wall, and, at the time of examination, had not been marred by the walk previously mentioned. This walk was built directly along the summit, which was smoothed for this purpose, thus almost obliterating the upper terrace, and lowering the whole crest. Previously, the wall has remained substantially as originally formed, for its steepness and height were such that, as a path, it was far from alluring. But now along its landward base runs the road from Little Boar's Head to Rye Beach; the situation of this road has been materially changed by the encroachments of the sea during the last fifty years, and its old location is approximately indicated on the diagram by the dotted line.

At the highest point of the crescent—near its middle—the road is about twelve feet below the summit of the wall, and only four or five feet above high-water mark. Diagram number two is a cross-section at this place, drawn to scale from personal measurements. The slope inward, it will be noticed, is comparatively gradual and quite regular, while the sea-face is formed in terraces, very regular and individually steep. The general seaward angle of inclination is

fully twice as great as the landward slope, and possesses some decidedly interesting characteristics. In the first place, it is singularly regular, varying but a very few degrees throughout its entire length; secondly, it is almost exactly the angle that such a mass of pebbles

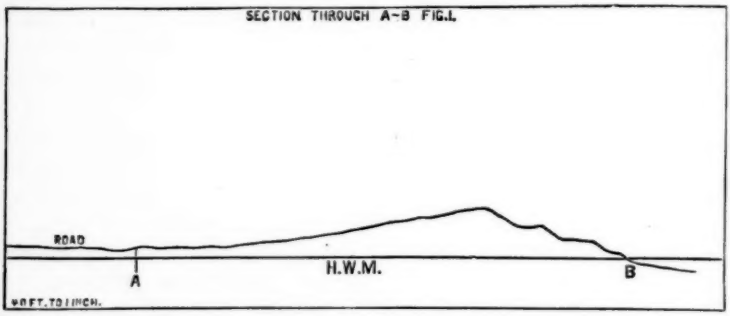



FIG. 2.

would take if uninfluenced by the action of the waves. Constant washing has adjusted it precisely as if the pile had been left to its own conditions of equilibrium.

The general angle of the upper terrace is 29°. It has undoubtedly been lessened by travel, and by the fact that it is out of reach of any but the higher waves, and the constant tendency, therefore, is toward undermining it. This terrace is composed of rather large stones, quite unmixed with sand or gravel.

The second terrace is steeper, 32° nearly. It is exposed to the high tides, and its surface is made up of rather small stones, distributed with great regularity, still unmixed with gravel, but compacted by the waves to a remarkable degree of solidity.

The lower terrace has nearly the same angle as the middle one, but its composition is very different. The pebbles are of small size, mixed with much coarse gravel and sand, and pounded by the constant washing of every tide into a hard, smooth, regular slope that effectually resists any attempt at undermining.

The general angle of the wall as a whole is within a few minutes of 30°, as nearly as could be determined. Owing to the rough instrument employed—a simple arrangement of plumb-line and semicircular protractor—the angles could only be measured to the nearest half degree, but the number of measurements taken leaves little doubt as to the accuracy of the result.

The size of the stones in some parts of the formation may give an idea of the tremendous force of the rushing waves that produced it. Stones of from twenty to thirty pounds in weight are common along the crest of the wall, fifteen feet at least above high-water mark. And not only this, but stones of the same size have been thrown completely over the wall into the road, more than a hundred feet from the

water. After a severe storm the road is sometimes strewed thickly with these great pebbles, and some trouble is necessary to clear it. So, at least, says popular tradition, but it is probable that very many of the larger stones, found some rods inland, were deposited there before the wall existed in anything like its present condition. For it is almost certain, from the character of the formation and its known history, that it has been piled up in comparatively recent times.

Some of the old inhabitants assert that the terrific storm that in 1851 devastated the whole New England coast and snapped like pipe-stems the iron pillars of the Minot's Ledge light-house, is responsible, too, for the wall. While that noted storm certainly did perform some tremendous feats, and in some places permanently changed the contour of the shore, no one storm could do its work in a very systematic or regular fashion. No one storm could have formed the three terraces that compose the sea-face of our wall. The Minot's Ledge storm may have greatly augmented an existing pile and changed its shape somewhat (as there is reason to believe it did), but, powerful as it was, it did not do anything more than this.

It is said that the above-mentioned storm so blockaded the existing highway that it was moved a short distance inland, and there is evidence to show that this road once ran near the present high-water mark, on or about the line now occupied by the wall.

It is, then, probable that a double process has been going on. The sea has been encroaching on the beach, and at the same time obstructing its own course with the *débris* of former invasions. It is worthy of notice that the wall has only been thrown up along the sandy beach, where the waves had an unobstructed passage. On the ledges that are of frequent occurrence no signs of any extensive deposit are visible. The wall is absent or much modified where a shoal intervenes. These facts show that the deposit has been the result of successive storms heaping up the material, and the ordinary course of the waves and tides molding and arranging it. When the angle of the pile exceeded the natural slope of such materials, growth in that particular plane ceased, and a terrace was formed. Thus the wall, as far as its seaward side is concerned, seems to be a sort of concretion, the terraces being formed in succession, partly out of new material furnished by annual storms and partly from what was left after the first terrace had reached its present angle. Constant pounding of the waves has solidified the wall, though various storms have partially undermined it and necessitated the re-formation of its face. To these storms is due the motion landward that has from time to time taken place. The materials of the wall have been collected from a large area, as is shown by their diverse character, and why they should have been deposited at this particular point is a matter of some doubt. It may be that submarine ledges off this part of the coast have furnished a quarry for the waves. The method of formation, however, has

been substantially as above recorded, and the results have been of such a curious character as to be well worth a visit from those interested in the influence of the sea in modifying and eroding the coast.

## THE TELEPHONE, WITH A SKETCH OF ITS INVENTOR, PHILIPP REIS.

By WILLIAM F. CHANNING, M. D.

A BOOK of absorbing public interest is announced shortly to appear in England and this country—a history of the telephone of Johann Philipp Reis, with a biographical sketch of its inventor, by Professor Sylvanus P. Thompson.

The telephone outranks all previous discoveries in its direct enlargement of human power. The telescope and microscope are its nearest compeers. The telegraph, beside it, is a clumsy mechanism. The telephone, which makes a whispering-gallery of the round earth, may well exert an influence on civilization, comparable with that of the railroad and steamship. Already the business centers expand, and the values of city lands change, under the magic of an invention which places every man at every other man's ear. But this promise or prophecy of the telephone is not all that affects the interest of the American people. There is a menace in connection with its present history which justly awakens public concern. Rapacious hands have clutched the throat of the telephone, to extort oppressive tribute for every word which it utters.

Professor Thompson's book, which treats exhaustively the early history of the telephone, is therefore not only of scientific but of social interest and importance. It establishes beyond honest doubt or question, by historical evidence, by the reproduction of original documents and illustrations, and by the public records of scientific bodies, that Philipp Reis discovered *the electric transmission of speech* in 1860–'61; that he elaborately described and exhibited his telephone in 1861; that he invented transmitting and receiving instruments, which not only talked then and talk now, but which include the essential principles of the transmitters and receivers now in use; and that he manufactured, placed on the market, and sold his instruments in 1863, for the purpose of illustrating the electric transmission of speech and song. That an invention so important, made in the heart of Germany, should not have been instantly perfected and utilized would surprise us in this country, if history did not abundantly teach that inventions complete in themselves often lie sterile until the favorable season and soil are found for their commercial adoption and development.

The following pages are a hurried and imperfect abstract from advanced-sheets of this book, which, besides its wealth of historical matter and its affluence of illustration, contains much of scientific value contributed directly by Professor Thompson.

The biographical sketch of Reis, with which the book begins, possesses an interest independent of his connection with the telephone. PHILIPP REIS, as he is generally called, was born January 7, 1834, in the small provincial town of Gelnhausen in Cassel, in which his father was a master-baker and farmer. His education began with the best of all teaching—object-teaching by his father, and moral and religious inculcation by a grandmother. The German common school followed, in which his early proficiency induced plans for a higher education, which were thwarted by his father's death when Philipp was less than ten years old.

He, however, went to the institute at Friedrichsdorf, where he became specially interested in the study of English and French, and where the valuable library of the institution was a store of nourishment for his mind. At fourteen he was promoted to Hassel's Institute at Frankfort-on-the-Main. Here he learned Latin and Italian, and distinguished himself by his devotion to the natural sciences and mathematics.

Compelled at sixteen to enter as an apprentice in a color establishment, he devoted all his leisure time to his continued education. A little later he is at the institute of Dr. Poppe in Frankfort, and one of several young men who mutually instructed each other. This experience induced Reis to look forward to teaching as his future vocation.

In 1851 he became a member of the Physical Society of Frankfort, of which Professor Böttger, Professor Abbe, and Dr. Oppel were active members. In 1855 he gave his year of military service. In Frankfort again, with marvelous energy he worked in the laboratory and pursued the higher branches of education. In 1858 he accepted a position as teacher in natural science in the institute of Hofrath Garnier, in Friedrichsdorf, the same in which he had been a student; and in 1859 he married and founded his peaceful home.

In 1859 he undertook an original research "On the Radiation of Electricity," and a paper on the subject, offered to Poggendorf for his "Annalen," was declined—the rejection being felt as a serious blow by the young and sensitive teacher.

His lessons in physics in 1860 stimulated him to the construction of the first electric telephone, which, indeed, he had attempted several years before. In a little workshop behind his house he made the first telephone with his own hands, carrying the wires thence to an upper room of the dwelling, and also from the physical cabinet of Garnier's Institute across the play-ground into one of the class-rooms, for experimental telephonic communication—the boys, it is said, being

afraid to make a noise in the class-room lest Herr Reis should hear them while among his instruments.

In 1861 Reis exhibited his telephone to the Physical Society of Frankfort, and his elaborate and illustrated memoir on that occasion appears in its "Annual" for 1860–'61.

In 1862 Reis sent a memoir on the telephone to Poggendorf for his "Annalen," which was again declined, despite the advocacy of Professor Böttger and Professor Müller of Freiburg—Poggendorf "treating the transmission of speech by electricity as a myth." Reis felt this rejection very keenly, ascribing it to his inferior position as a poor schoolmaster.

Between 1861 and 1864 Reis gave public exhibitions of his telephone before various scientific bodies, and it became widely known. In addition to his own lectures and papers on the telephone, it was the subject of lectures and reports by prominent men in various parts of Germany, and in 1863 it was exhibited to the Emperor of Austria and King Max of Bavaria, then on a visit to Frankfort. Telephones, also, were sent to various parts of the world, and were manufactured for Reis by Albert, of Frankfort, and sold for scientific illustrative use in 1863. It is related that, in September, 1864, after a successful exhibition before the Association of German Naturalists at Giessen, he received at last an invitation from Poggendorf to prepare an account of the telephone for the "Annalen." Reis replied, thanking him, and telling him that it was too late, that he should not send it, and that his apparatus would become known without description in the "Annalen."

If this offer had not been refused by Reis, the diffusion of the telephone would probably have taken place at a much earlier day. It did not, however, pass out of sight. It was figured and described in encyclopædias and text-books in different languages. Reis's telephone in England was the subject of experiment and improvement; and it is even rumored with a good deal of probability that his instruments were so far improved in a German neighborhood in Pennsylvania that fluent talking was obtained some years before the revival of the telephone in this country by Gray and Bell.

The year 1864 was probably the culminating point of Reis's career in connection with the telephone, though his labors continued. He proclaimed the invention of the speaking telephone as an accomplished scientific fact, and confidently predicted its practical commercial application. The indifference with which his discovery was often received, and the rebuffs which he encountered, told on a sensitive temperament, and still more on a body struggling with a fatal disease in the early prime of life. For several years he discharged his professional duties only by great effort. We can see the poor schoolmaster of Friedrichsdorf, who had created the telephone, striving at disadvantage to earn the necessaries of life for his wife and children, though we have

no precise information of his family. Disabled finally by hæmorrhage of the lungs and loss of voice, he disposed of all his instruments to Garnier's Institute, and died of consumption, January 14, 1874, at forty years of age.

Four years later, in 1878, the Physical Society of Frankfort erected an obelisk of red sandstone over his grave in Friedrichsdorf bearing upon it a medallion of the great inventor.

The description of Reis's telephone is divided naturally into two sections. Here, fully illustrated in Professor Thompson's book, we have ten forms of transmitter, all imitating the mechanism of the ear, and applying the vibrations of an artificial tympanum to vary or modulate a current of electricity, by varying the degree of contact at a loose joint in the circuit, one or both of the members at this point of contact having an elastic bearing. This is the essential principle and method, leaving out certain adjuncts, of the most approved modern transmitters. In the very first transmitter made by Reis, in 1860 or 1861, a little curved lever is attached by one end to the center of an elastic tympanum, while the other end makes varying contact with a delicate spring, regulated by an adjusting screw—the surfaces of contact being of platinum—and the lever and spring included in a telephonic circuit equipped with a galvanic battery and receiver.

Of the receivers four forms are given. The first receiver made by Reis consisted of a knitting-needle wound with a helix of silk-covered copper wire, one end of which knitting-needle was thrust into the bridge of a violin, which served as a sounding box. This instrument was given to Reis for the purpose by Herr Peter, the music-teacher of Garnier Institute, and it is now preserved with other relics in the museum of that institution. In the second form the helix was laid horizontally upon a sounding-box (a cigar-box), and the knitting-needle, passed through it without contact, was supported by a "bridge" at each end. The third form was the electro-magnetic which will be described in connection with Fig. 1. Of this class of receivers Reis himself writes, "Electro-magnetism affords the possibility of calling into life, at any given distance, vibrations similar to the vibrations that have been produced (in the transmitter), and in this way to give out again in one place tones (sounds) that have been produced in another place." In the fourth form of receiver Reis recurred to the "knitting needle," more elaborately arranged. This is shown in Fig. 2.

Among these instruments of Reis are two noteworthy types of transmitter and two of receiver. They all happen to be grouped in two very early illustrations, published in the proceedings of learned bodies, and therefore of the highest authenticity. The first of these is contained in the report by Wilhelm von Legat to the Austro-German Telegraph Verein in 1862, printed in the journal of that society, and reprinted verbatim in Dingler's "Polytechnisches Journal" for 1863. This is shown in Fig. 1.

The transmitter in Fig. 1 consists of a conical tube, *a*, closed at the smaller end by a collodion membrane, *o*, on the center of which rests the end of a very light bent lever, *c d*, supported at *e*, and thrown

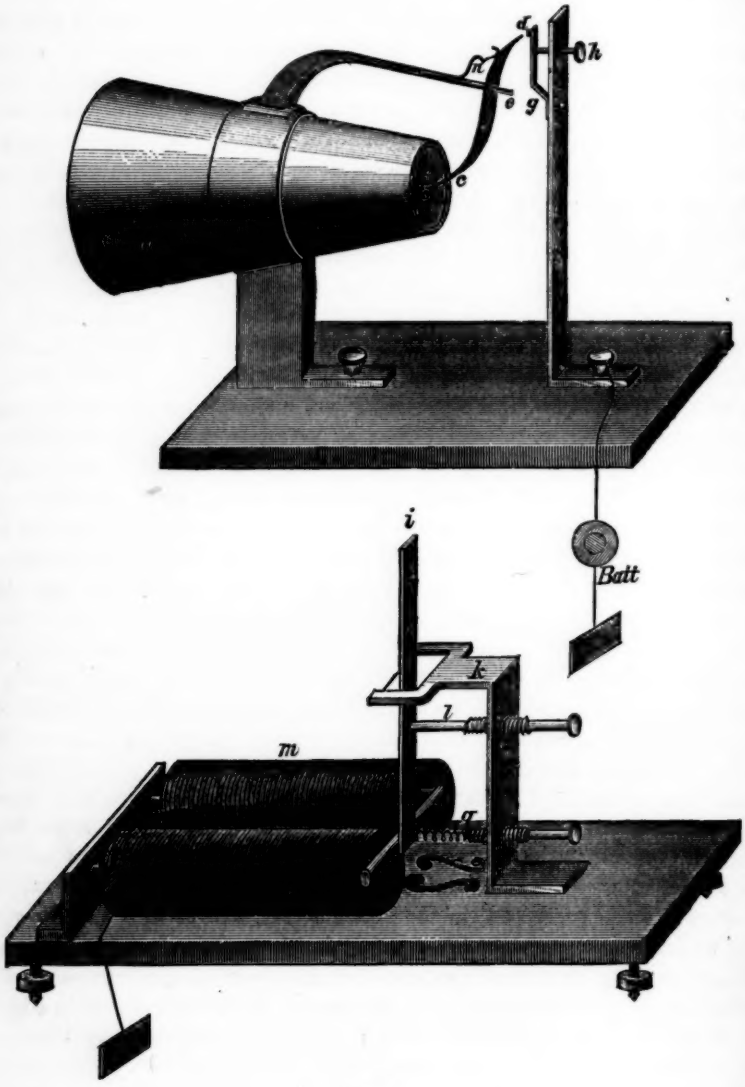



Fig. 1.

forward into contact with the spring *g* by the delicate spring *n*. The spring *g* is adjustable by the screw *h*. The electric connections will be easily traced. In the description, *g* is explicitly described as *a spring;* and the essential feature to be observed in this type is the current

regulator, or loose-contact mechanism, consisting of the spring *g* bearing on the lever *c d*, actuated by the elastic membrane *o*.

The receiver in this figure consists of an electro-magnet, *m*, on a sounding-board, with an armature, regulated by an adjustable spring, *g*, pendulum-mounted, and "connected with a lever, *i*, which is as long as possible, but light and broad." This expansion of the armature is for the purpose of increasing its superficial contact with the air for the propagation of sound-waves. The Reis armature, so equipped, is the equivalent of the "diaphragm" in what is commonly called "the Bell receiver," a form, however, which appears to have originated with Elisha Gray. In the "Bell receiver" the diaphragm is an elastic, expanded, circular armature. The Reis electro-magnetic receiver is thus a complete and perfect anticipation of that of Yeates, of Dublin, in 1865, and of the later receiver of Gray or Bell. The function of all is to move an elastically supported armature backward and forward, and so throw it into vibrations corresponding to those imparted by the sound-waves to the transmitting apparatus.

Fig. 2 is copied from the "Prospectus" of Reis, dated August, 1863, containing instructions to accompany the telephones constructed for him, and sold by W. Albert, of Frankfort. The transmitter here shown has been usually called the "box-instrument." In this type, instead of a spring adjustment of the current-regulator or loose-contact mechanism, as in Fig. 1, we have the angle-shaped "Hämmerchen," as Reis called it, or little hammer, poised on the supports *a b*,

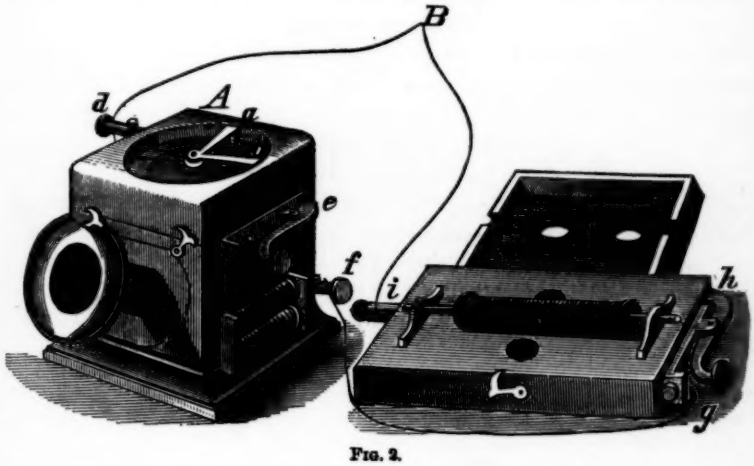



FIG. 2.

and resting *by gravity* on the strip of platinum-foil at the center of the tympanum seen below. A little drop of mercury at *b* makes perfect electric communication between the little hammer and neighboring screw-cup. The elastic feature of this loose-contact arrangement is confined to the animal or other membrane of the tympanum itself.

The mouth-tube communicates with the inside of the box or air-chamber, and the sound-waves act upon the tympanum from below. On the side of the box are seen a telegraph key, *e*, and sounder, for signalizing between the transmitting and receiving stations. This is the transmitter successfully used, as will be seen, by Yeates, in Dublin, in 1865. So sensitive was this transmitter that it was found unnecessary, in its early use, to speak directly into the mouth-piece; and in practice the speaker talked and sang at a little distance from it. In the reports of experiments with this instrument the rattling noises which were sometimes complained of as heard in the receiver were undoubtedly due to the complete breaking of the circuit by too loud talking or singing in the mouth-piece. The Berliner and Blake transmitters are liable, unless specially guarded, to the same misadventure from the same cause.

The receiver in Fig. 2 is Reis's latest form of the "knitting-needle" instrument. A helix of insulated wire is attached horizontally to a sounding-box. Through the helix a steel wire or knitting-needle is passed without contact, and supported at each end by a bridge. The vibrations of this knitting-needle magnet, corresponding exactly to the vibrations of the tympanum of the transmitter, are converted into sound-waves by the extended surface of the box acting upon the air. On the side of the box is a telegraph-key to communicate back to the transmitter. The code of signals suggested in the accompanying "Prospectus" contains the following:

"One tap = sing.
Two taps = speak."

An original telegraphic letter alphabet is also suggested, showing how slight was Reis's acquaintance with ordinary telegraphing.

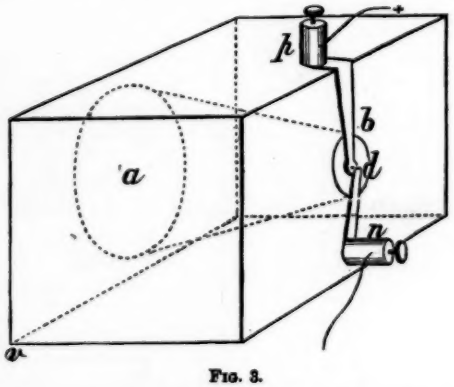



FIG. 3.

Fig. 3 represents the form of transmitter, figured and described by Reis in his first memoir of 1861. I present it, out of chronological order, on account of its simplicity and close resemblance to the modern transmitters. A conical chamber, *a b*, is bored through a cubical

block and is closed at *d* by a membrane. A platinum strip, *b*, extends from the screw-cup *p*, to the center of the membrane *d*, to which it is attached. From the screw-cup *n* a spring, *n d*, carrying a platinum style, makes contact at *d* with the platinum strip *p d*. This original instrument, presented by Reis to Professor Böttger, is now in the possession of Professor Thompson. It has an adjusting screw in the course of the spring *n d*.

Reis's claim as an inventor is discussed by Professor Thompson and fully substantiated under the three following heads: "1. Reis's telephone *was expressly intended to transmit speech.* 2. Reis's telephone, *in the hands of Reis and his contemporaries, did transmit speech.* 3. Reis's telephone *will transmit speech.*" Before bringing forward evidence on these points, Professor Thompson disposes of a current prejudice against Reis's telephone, which has been not altogether innocently created. It has been called a "tone-telephone," or musical telephone, by those interested in relegating it to the category of harmonic instruments. Reis called it neither an articulating nor tone telephone, but simply "Das Telephon." He spoke habitually of reproducing any and all sounds through its agency, the German word used being *Ton*, plural *Töne*, which is nearly the equivalent of our English word "sound." By transferring the German word (untranslated) to the English it has been attempted to narrow the scope of his discovery as stated in his own words. It is in place here to say that Reis was no musician, and could hardly distinguish one tune from another.

Reis's first memoir on the telephone, delivered before the Physical Society of Frankfort-on-the-Main, in 1861, and printed in their "Annual" for the same year, begins thus: "The surprising results in the domain of telegraphy have often already suggested the question whether it may not be possible to communicate the very 'tones' [sounds] of speech direct to a distance." He says that "the cardinal question" always was "how could a single instrument reproduce at once the total action of all the organs operated by human speech." Could the expression of intention be plainer? He says, again: "Until now [1861], it has not been possible to reproduce the 'tones' [sounds] of human speech with a distinctness to satisfy everybody. *The consonants are for the most part tolerably distinctly reproduced, but the vowels not yet in an equal degree.*" Was this only a "tone-telephone"? He proceeds to show the cause of the difficulty in the case of vowels by diagrams of the undulating curves representing consonant and vowel sounds. The memoir concludes thus: "There may probably remain much to be done toward making the telephone *of practical commercial value.* For physics, however, it has already sufficient interest in that it has opened out a new field of labor. . . . Philipp Reis, December, 1861." It will be observed that this date precedes the improved forms of Reis's telephone, by which the some-

what better practical articulation, hereafter testified to, was obtained. But, even on this showing, what can be plainer than that Reis was the originator of the new art of the electrical transmission of speech? Granting that the articulation at this time, and even in 1864, was poor—poorer even than Gray's in 1875, and Bell's in the spring of 1876—it was still articulation, understood where the words were not foreknown by the listener.

With regard to the present capability of Reis's instruments, Professor Thompson says that he has found the Reis transmitters competent to transmit both vowels and consonants with perfect distinctness; and from Reis's "knitting-needle receiver he has obtained articulation, exceeding, in perfection of definition of vowels and consonants, the articulation of *any other telephone receiver he has ever listened to.*"

Among other contemporary documents, the important report of Legat on Reis's telephone to the Austro-German Telegraph Society in 1862 is reproduced in full. From this report we have taken one of the illustrations in this paper. The report is not only a description of Reis's instruments, but an elaborate discussion of the problems connected with the telephonic reproduction of sounds, including the transmission of speech. The documents of this date show that the subject of telephony was usually studied in connection with vocal song rather than simple speech, and that the transmission of musical sounds, which was generally successful, was preferred for illustration to the more difficult, but also much more important, transmission of words and sentences. But the fact of articulation continually appears.

In a chapter containing the testimony of contemporary witnesses, Professor G. Quincke, Professor of Physics in the University of Heidelberg, writes, under date of March 10, 1883, that he was present at Reis's exhibition before the Naturforscher Versamlung, at Giessen, 1864. He says: "I heard distinctly both singing and talking. I distinctly remember having heard the words of the German poem:

"'Ach, du lieber Augustin,
Alles ist hin,'" etc.

Ernst Horkeimer, a pupil of Reis, writes that he assisted him in most of his experiments prior to the spring of 1862; that the transmission of speech was Reis's chief aim; "the transmitting of musical tones being only an after-thought, worked out for the convenience of public exhibition," and that some words were successfully transmitted without previous arrangement, but not (at that date) whole sentences. He states that Reis anticipated the use of thin metallic tympanums, and tried one, varnished with shellac on both sides, except the central point of contact.

Léon Garnier, proprietor and principal of the institute of which Reis was a teacher, states that he often talked with Reis through his

telephone for an hour at a time, the distance of the stations from each other being about one hundred and fifty feet. He says: "I remember especially that—Mr. Reis speaking through his instrument—I distinctly heard the words, 'Guten Morgen, Herr Fischer'; 'Ich komme gleich'; 'Passe auf'; 'Wie viel Uhr ist es?' 'Wie heisst du?'" Heinrich Hold, a colleague of Reis in the same institute, gives detailed testimony of talking successfully through the telephone. Heinrich F. Peter, the musical teacher, then and still at Garnier's Institute, says, "Philipp Schmidt read long sentences from Spiess's 'Turnbuch,' which sentences Philipp Reis, who was listening, understood perfectly, and repeated to us." Being incredulous, and to further test it, Herr Peter spoke some impromptu nonsensical sentences through the telephone, such as "Die Sonne ist von Kupfer," which Reis understood as "Die Sonne ist von Zucker."

Mr. S. M. Yeates, instrument-maker of Dublin, writes that in 1865 he exhibited Reis's telephone to the Dublin Philosophical Society, substituting an improved electro-magnetic receiver for the knitting-needle receiver (shown in Fig. 2), the transmitter being the same as in that figure. Yeates's receiver was an electro-magnet with a vibrating armature, mounted on a spring attached to a sounding-box. William Frazer, M. D., member of the Council of the Royal Irish Academy, writes, March 13, 1883, that he was present on this occasion, that various questions were asked and answered, and that "the separate words were most distinct, the singing less so." The individual who spoke was easily recognized by his voice. (It has been stated elsewhere that Yeates improved the Reis transmitter by placing a drop of water between the platinum surfaces of loose contact.)

In an appendix, which is not really separable from nor less important than the rest of the work, Professor Thompson discusses the relation of Reis's instruments to those now in use, and also Reis's development and use of the variable or "undulatory" electric current, corresponding to the undulatory curves of sound-pressure, which he graphically represents, and to which he often refers.

In the first section, Professor Thompson points out that Reis's transmitters preserve throughout, first, the tympanum to collect the voice-waves, and, second, two or more electric elements in loose or imperfect contact with each other, so combined with the tympanum that the motions of the latter correspondingly alter the current of electricity flowing between the contact-pieces. Reis's apparatus is not, therefore, an "interruptor," but a "current-regulator." The contact-pieces, one or both, were mounted with adjustable springs, or held together by gravity, so as to vary the current without completely breaking contact, in the same way, and for the same purpose, as in the Berliner, Blake, and other modern transmitters. Disregarding induction-coils and other accessories, the fundamental principle of these later instruments is the combination of a tympanum with a cur-

rent-regulator, identical with the combination used by Reis. Too loud shouting in either the Reis or Blake transmitters spoils the articulation by breaking the circuit.

Reis's transmitters have been called make- and break-circuit instruments. If so, the Berliner and Blake transmitters, operating on the same principle, are also make- and break-circuit instruments. If, on the other hand, the Berliner and Blake transmitters, by their current-regulators, determine undulatory electric currents, in correspondence with the sound-waves, the Reis transmitters, by the same mechanism, necessarily do the same.

The identity of the mechanism of the current-regulators in four of Reis's transmitters with the mechanism in six modern forms of transmitter is strikingly exhibited by Professor Thompson in a comparative plate.

In connection with the Reis current-regulator, now in almost universal use, it has been in later times found generally advisable to use an induction-coil. It is an interesting fact in the evolution of the telephone, though it may not be stated in the book before us, that Ferguson's chemistry, published in 1868, states that Dr. Wright in England used a Reis transmitter in the primary circuit of an induction-coil. The combination of current-regulator and induction-coil in the modern transmitters is therefore old.

In the third section of the appendix, Reis's receivers are compared with recent instruments. The examination in this case, also, is much aided by a comparative plate. Reis's electro-magnetic receiver is shown to combine the three following essential elements, which enter into the Yeates, Gray, Bell, Edison, and other receivers: 1. An armature acted on by an electro-magnet; 2. An armature elastically mounted; 3. An armature of sufficiently extended surface to set in motion aërial sound-waves. This discussion has been anticipated in previous pages. Professor Thompson, in summing up his close analysis, points to Reis as the genius by whom the essential principles of all the electro-magnetic receivers now in use were discovered and combined so as to reproduce articulate speech.

A section in the appendix is devoted to the "undulatory" current in Reis's telephone. We have already seen that the function of the Reis transmitter was to vary the strength of the electric current, and not to break it. Reis was accustomed to speak of opening and closing the circuit in describing these instruments, not in the technical sense of modern telegraphy, nor with the idea of sending intermittent signals, but in the sense of increasing or diminishing the current, without going so far as absolutely to break it. This is abundantly proved by the context in his descriptions, and by the operation of his instruments. He states, in his first memoir, that, to reproduce any sound, or combination of sounds, all that is necessary is to set up in the receiver vibrations whose curves are identical with those of the

sounds, or combination of sounds, in the transmitter. And he represents graphically the undulatory curves of consonant and vowel sounds, by way of illustration. Between the transmitter and receiver, on whose necessary identity of vibrations he constantly insists, he employs an electric current as the intermediate, to take on, in its wave-motions or polarizations, all the possible variations of the sound-waves striking on the transmitter, and to give them up again to the receiver. Reis, without talking about "undulatory" currents, makes them the staple of his telephone.

Professor Thompson, without the least imputation of plagiarism, shows, in parallel columns, the identity of expression between Reis and Bell, in their statement of the essential principles of the telephone. The impression of the identity of Reis's and Bell's discovery grows, page by page, during the perusal of this book.

The conclusion reached by Professor Thompson, from the survey of the whole field—a conclusion which seems to be fully borne out by the facts adduced—is the following: "There is not, in the telephone exchanges of England to-day, any single telephone to be found in which the fundamental principles of Reis's telephone are not the essential and indispensable features."

This conclusion makes the speaking telephone, in its elementary form, free to the whole world. It opens wide the door for the future development of the telephone; and it should assure to all those who, by their genius and industry, in our day and generation, have improved or may improve the telephone, an ample pecuniary reward. The recompense due to the family of Philipp Reis should take the form hereafter not of a tax, but a free gift from the world's gratitude.

This book comes, then, as a charter of freedom of speech in a larger sphere than ever before known.

In the light of historic facts which this book establishes, the decision of the courts of the United States that Professor Bell is the discoverer of a new and useful art (the electric transmission of speech), to which he has exclusive title, must be reversed as speedily as possible, that our courts may retain the respect of the people of the United States.

# CORRESPONDENCE.

## DEVELOPING A NEW INSTINCT.

*Messrs. Editors:*

A COW (half Jersey) ran with others in an orchard, and showed herself exceedingly fond of green, sour apples. So persistently did she "go for them," that it was suggested she would climb the trees yet. But she did not take to climbing; she invented another method: she took to shaking the limbs.

At first she reached directly for the fruit and foliage, but at the same time, no doubt, observed that, when the limb sprang back, apples fell to the ground. This left an impression known as memory; and, at length, keeping hold of the limb with her teeth, she shook it precisely as a man would, jerking it downward a number of times in quick succession, and then letting go her hold to pick up the apples. I once drove her away from a tree which she was relieving of its fruit rather successfully, when she went to another tree, apparently intent on business, seeming to have forgotten that she had previously shaken off all the apples within reach; but, when there, she either observed that there was no fruit to shake off, or else recollected that she had already harvested all that was to be had; at any rate, she did no shaking.

To protect the fruit against her fertile genius, I tied her head to a fore-leg, with about twenty inches interval between them. She would then support herself on three legs, lift up the fourth one and seize with her teeth limbs as much as five feet from the ground, and shake them as skillfully as before.

In this case there is no mistake about the fact. I have witnessed the novel performance many times; and, when not looking, I have heard the peculiar sound of the shaking limb and falling apples, and realized how strikingly suggestive it was of a human presence. The animal is now four years old, and has given exhibitions of her skill the last two summers.

This trick was not learned by witnessing a like act of man or animal. It was independently invented through suggestion, as a human being would independently invent a mechanical process. The animal in question is not any wiser than her comrades in other respects; but, though she invented limb-shaking for herself, they have not taken the first step toward imitating her. Still it would be plausible to suppose that other cattle, especially her own offspring, would come to follow her example by-and-by, and that if they ran constantly in apple-orchards they might become permanently endowed with the limb-shaking instinct—not of miraculous but of purely utilitarian origin.

J. S. PATTERSON.

BERLIN HEIGHTS, OHIO, *April*, 1883.

## THE AGE OF TREES.

*Messrs. Editors:*

IN the December number of "The Popular Science Monthly" I observe an article by A. L. Childs, M. D., stating that the old notion that a person could tell the age of a tree by the number of the concentric rings shown on a cross-section of the timber was a fallacy, and giving some facts to sustain the theory advanced. As the "Monthly" is searching for the truth only on scientific questions, permit me to give a few facts, which tend to support the old theory that Dr. Childs attacks.

When Virginia ceded to the United States the territory northwest of the river Ohio, she reserved all the lands lying between the Scioto and Little Miami Rivers, in order to satisfy the bounty lands given by her to her soldiers who had served in the Revolutionary War. The State of Virginia had given lands varying in quantity from one hundred acres to a private soldier, five thousand acres to a colonel, to fifteen thousand acres to a major-general, to all those who had served as such soldiers and officers during the war, and issued what were termed "land-warrants" to such soldiers and officers for the land to which each was entitled. These parties took the "land-warrants" thus issued to them, and made their own entries of the lands called for on any vacant land in the district, describing the same on the "Book of Entries," and then had these entries surveyed by the surveyor of the district, who marked the boundaries and corners of the several surveys on the growing timber, by hacking the same that happened to be standing along the lines of the surveys or near the corners thereof; and on these surveys being returned by the holder to the General Land-Office, at Washington city, the Government issued a patent for the land thus surveyed to the holder of the warrant, his heirs and assigns. Some of these surveys were made before General Anthony Wayne defeated the Indian tribes in 1794, and others were made as late as 1857. From the fact that parties made their own entries, there were many overlapping and interfering entries and surveys, and very frequently junior entries and surveys obtained the first patent. (Some of the en-

tries are not yet surveyed, and some of the surveys not yet patented.) Out of this system endless confusion and litigation arose in settling the disputed lines and overlapping entries and surveys.

This litigation was not wholly settled until long after I came to the bar, in 1847, and it was my fortune to be engaged in many of these cases. In the trial of these cases it very frequently became important to show the date of the surveys. These dates were shown by the indorsement on the survey itself, and corroborated by an examination of the hacks on the line and corner trees of the survey. These hacks invariably left a scar, which, to the practical surveyor, was readily detected, even after a lapse of sixty years. By "blocking" the tree, as it was called, and taking the block and counting the concentric rings, from the hack made by the surveyor to the outside of the tree, it invariably corresponded with the dates as they appeared upon the returns made by the surveyor, showing as many rings as years had elapsed from the date of the survey, thus proving that for each year of the life of the tree an additional concentric ring had been added.

The prevailing timber was oak, in its many varieties, and they were rarely marked unless they were at least four inches and upward in diameter. It will be very difficult to convince an old surveyor, or an old lawyer who has tried many of these land cases, that each concentric ring, on an oak-tree at least, does not indicate a year's growth only of such tree.

Judge N. H. Swayne, late of the Supreme Court of the United States, but now residing in New York city, practiced for many years, before he was called to a seat on the bench, in the Virginia military district, and is familiar with these facts. If you will drop a note to him, he will corroborate me. P. C. SMITH.

CIRCLEVILLE, OHIO, *January* 3, 1883.

---

## WOHLER AND "VITAL ENERGY."

*Messrs. Editors:*

IN the June issue of your magazine (vol. xxiii, No. II), in the opening paragraph of an article entitled "Darwin and Copernicus," reference is made to Wöhler as the "chemist who by the first organic synthesis helped to dispel the illusion of vital energy." Have the artificial production of urea by synthesis and subsequent achievements in that line satisfied scientists that vital energy is an *illusion*, or does Du Bois-Reymond so characterize it upon the basis of his own *speculations* and the *conjecture* of a school of physicists? If the non-existence of vital energy has not been demonstrated beyond question, does he not violate "scientific candor" in his assertion? A well-known chemist, for several years pupil and assistant of Wöhler, familiar with his work, and conversant with later chemical research, has told me that in his judgment the expression referred to above is unwarrantable.

Very respectfully,

AUSTIN B. BASSETT,
*Department of Physics, Massachusetts Agricultural College.*

AMHERST, *June* 5, 1883.

---

## TEACHING ENGLISH.

*Messrs. Editors:*

NOT long since the Board of Education in this city decided to employ a teacher of *English* and *Elocution* for their high-school, one of the largest for places of equal size in the country. But, although the University of Michigan, with its fourteen hundred students, is situated here, no one could be found among its graduates competent to teach how to write the most important and forcible of all languages, our own mother-tongue, and at the same time speak it with ease, grace, and the most artistic expression. Hundreds are prepared to teach dead languages, none to write and speak the English, and hence a teacher had to be imported. Herbert Spencer's question, "What knowledge is of most worth?" is very pertinent here. Why so much time on dead languages, and none on speaking our own?

X.

ANN ARBOR, MICH., *June* 26, 1883.

---

## THE CASE OF THE DOG PLUTO.

*Messrs. Editors:*

IN your issue of the present month appears the article of Mr. Eugene N. S. Ringueberg, describing the strange actions of his pointer Pluto. It seems to me a strained explanation which attributes the conduct of this dog, as described, to *superstition* or the fear of ghosts, etc.

In your number of April last was a paper on "Perceptional Insanities," by Dr. W. A. Hammond, and any person who has read that article, or who is otherwise at all familiar with the subject of illusions and hallucinations, must recognize the fact that all which is related by Mr. Ringueberg is more reasonably to be accounted for by supposing Pluto to have been a victim of *perceptional insanity*.

The animals, sharing much with man even as to mental or spiritual qualities, are, like him, subject to madness and insanity, and there is no reason for supposing that they do not occasionally suffer from deception of the senses. In the case of Pluto, the first noticed attack followed immediately upon hearing the noise caused by the falling of a stick of wood in the stove behind which the dog was sleeping. It seems prob-

able that the sudden clatter impressed the startled animal as being the sound uttered by some dangerous enemy. If such were the case, it was natural for the beast to search for the thing itself that terrified him, which in fact was done, for he immediately fastened his gaze upon the leaf that lay on the floor and commenced against it his timid hostilities. This conduct upon his part justifies the inference that the noise of the falling stick suggested a visible enemy, possibly a serpent; and so, the withdrawing of his paw accompanied by the licking of it would seem to tell us that the illusion or hallucination affected the sense of touch as well as those of hearing and sight.

Having once passed through this experience as following the hearing of the noise made by the falling stick, it was natural that there should be an association within him between sudden noises in general and the thing of terror, and hence, as Mr. Ringueberg tells us, he was apt to be thrown by such noises into paroxysms; and so, the sound which caused the first trouble having arisen in the kitchen, noises coming subsequently from that quarter were the most disturbing to him, just as stated. Proceeding one step further, as the first attack came upon Pluto in the kitchen, it was natural for him to regard that spot as the abiding-place of this enemy, and to show signs of terror, as he did, at all times when passing through that apartment. And, when particularly disposed to a violent attack, the association of ideas connected with the kitchen was most likely to there bring upon him the climax of his trouble.

Mr. Ringueberg speaks always of these paroxysms as accompanied by a fixed staring at some particular object, whether a spot upon the ceiling, a hanging towel, or something else, and a terrified retreat therefrom; all of which suggests a false sight, bringing up the image of some *material* enemy, and it is rather imaginative, under all the circumstances, to suppose that it was ghosts, or *things spiritual*, which he had before him, in imagination.

Respectfully yours,

FRANK MCGLOIN.

NEW ORLEANS, *May* 18, 1883.

## EDITOR'S TABLE.

### *HERBERT SPENCER AND THE FRENCH ACADEMY.*

MR. HERBERT SPENCER has been chosen a member of the Institute of France. We learn that he was elected in May by a nearly unanimous vote as a Foreign Correspondent of the Academy of Moral and Political Sciences, to fill a vacancy caused by the death of Henry P. Tappan, of Detroit. These academical distinctions are so often unworthily bestowed, that Mr. Spencer does not hold them in much esteem as indications of genuine merit; but, as it may be assumed that he is not indifferent to the good opinion of his eminent contemporaries, he will, no doubt, appreciate at its true worth this well-intended compliment, and make his acknowledgments accordingly.

But there is an interest in the transaction not confined to the immediate parties to it. When an institution, standing highest in the world as a dispenser of the titles to intellectual eminence, and which has become a kind of authoritative arbiter in such matters, undertakes to assign the position of a man like Spencer, there are many who will desire to know with what discrimination, and what rectitude of judgment, the award has been made. The honors of the Institute are not all of equal dignity: that of Foreign Associate is highest, while that of Foreign Correspondent is of secondary rank. The French academicians, after having certainly taken abundant time for deliberation, now decide that Mr. Spencer's claims are not such as to entitle him to the highest rank among the intellectual leaders of the time. We think the Academy has here made a considerable mistake, which it is important should be corrected.*

* It may be as well to say that we are not to expect too much from the French Academy. Its predominant historic spirit has been time-serving, and it is declared by high authority that, instead of fostering originality, it has rather been its policy to hamper and crush it. We should not, therefore, look to it for a very liberal appreciation of Herbert Spencer; his qualities, in fact, are very much those which it has not been its policy to honor. The following estimate of its influence, by M. Langfrey, is

By the theory of all such institutions, the relative rank of great men is a determinable thing. The supreme object of the Institute of France, through the organization of its five great Academies, is the extension and improvement of human knowledge in all its comprehensive departments; while, subsidiary to this object, it assumes the function of honoring the men in foreign countries who have contributed in eminent ways to this advance of knowledge. Mr. Spencer is, therefore, to be estimated by the import of his contributions to the progress of thought. The tests of pre-eminence here are not doubtful. To produce any wide or profound impression upon the state of knowledge at the present day requires the rarest order of mind. There must be a thorough mastery of many departments, comprehensive insight, great capacity of generalization and of organization, and the fertility of creative conception, the independence and the originality of ideas that belong to genius. It will not be difficult to show that Herbert Spencer possesses these traits in so marked a degree as to have made him a leading power in the greatest intellectual movement of modern times.

Mr. Spencer published in 1855 a philosophical treatise entitled "The Principles of Psychology," an original and powerful work, putting the science of mind upon a new basis, and which the best judge in England, John Stuart Mill, pronounced "the finest example we possess of the psychological method in its full power." This work anticipated and reduced to valid application in the highest phenomenal sphere those fundamental doctrines of nature and life which have since become firmly established in the scientific world. Holding the principle of evolution to be a fundamental truth while yet it was generally held to be a baseless speculation, he founded upon it a systematic exposition of the laws of mental phenomena. The constitution of mind was investigated by the genetic method, and the development of the mental elements, organic and psychical, was traced from their simplest to their most complex relations in correspondence with the phenomenal relations of environing nature, by intercourse with which all mind is unfolded. The book was greatly in advance of the age, and its significance was at first comprehended by only a few; but these were so powerfully affected by it that a new direction was given to psychological study, and its influence was soon widely recognized in the ablest literature of the subject.

A single illustration of its insight and originality may be here instanced. From early times down to the present, philosophers have been split into two parties over the question of the genesis of ideas, one maintaining that they are innate, and the other that they originate in experience. From Plato to Kant on the one side, and from Aristotle to Locke on the other side, the representatives of these schools have battled over the problem in thousands of futile books, which left the question as unsettled as they found it. Herbert Spencer solved the problem and reconciled the antagonism through the basal

---

probably but too correct. He says, in his "History of Napoleon": "Founded by the monarchy and for the monarchy, eminently favorable to the spirit of intrigue and favoritism, . . . wasting all its energies in childish tournaments, in which the flatteries that it showers on others are only the foretaste of the compliments it expects in return for itself, the French Academy seems to have received from its founders the special mission to transform genius into *bel-esprit*, and it would be hard to produce a man with talent whom it has not demoralized. . . . If we examine its influence on the national genius, we shall see that it has given it a flexibility, a brilliancy, a polish, which it never possessed before; but it has done so at the expense of its masculine qualities, its originality, its spontaneity, its vigor, its natural grace. It has disciplined it, but it has emasculated, impoverished, and rigidified it. It sees in taste not a sense of the beautiful, but a certain type of correctness, an elegant form of mediocrity. It has substituted pomp for grandeur, schoolroutine for individual inspiration, elaborateness for simplicity, *fadeur* and the monotony of literary orthodoxy for variety—the source and spring of literary life; and, in the works produced under its auspices, we discover the rhetorician and the writer, never the man. By all its traditions, the Academy was made to be the natural ornament of a monarchical society. Richelieu conceived and created it as a sort of superior centralization applied to intellect, as a high literary court to maintain intellectual unity and protest against innovation."

idea of evolution in the organic sphere —the principle of heredity. He showed that there is an element of truth in both views, and that, while on the one hand all ideas are derived from experience, it is not alone the experience of the individual, but the experience of the race and of ancestral races, by which the mental elements become organized, transmitted, and augmented in vast time, so that each individual is born with a heritage of innate and *a priori* aptitudes and capacities—the products of evolution. Thus the philosophical conflict of ages was harmonized in our own time, and the brilliancy of the solution is already tempting some of our ablest thinkers to venture the assertion of rival claims to the honor of having independently reached this great result. But the priority of Herbert Spencer is here impregnable, as is unreservedly conceded by the most competent authorities. We quote the last that comes to hand. Dr. Edmund Montgomery, in a masterly series of articles on "Causation and its Organic Conditions," recently contributed to "Mind," thus refers to Spencer's enunciation of the principle:

"Until quite recently I can not detect any movement in philosophy containing a germ of sufficient power to be capable of effecting by development the deliverance from the constant and almost fruitless see-sawing of the two schools. . . .

"Suddenly, however, light began to pierce the hitherto immovable darkness. It was Mr. Herbert Spencer who caught one of those rare revealing glimpses that initiate a new epoch in the history of thought. He saw that the evolution hypothesis 'furnishes a solution of the controversy between the disciples of Locke and Kant.' To us younger thinkers, into whose serious meditations Darwinism entered from the beginning as a potent solvent of many an ancient mystery, this reconciliation of transcendentalism and experientialism may have consistently presented itself as an evident corollary from the laws of heredity. But what an achievement for a solitary thinker, aided by no other light than the penetration of his own genius, before Darwinism was current, to discover this deeply-hidden secret of nature which with one stroke disclosed the true relation of innate and acquired faculties, an enigma over which so many generations of philosophers had pondered in vain!"

We speak far within bounds in saying that the book embodying these and kindred views, and recasting the most subtile and complex of the sciences, must be classed with the few great works of the century, the value of which, as a contribution to progressive thought, it is hard to overestimate.

Had Mr. Spencer done nothing more than to make his powerful contribution to the regeneration of mental philosophy, this capital service to the advance of thought should have been honorably signalized by the French Academy a quarter of a century ago. But this research only prepared the way for labors of greater magnitude. His system of Psychology, matured in thought in 1853, and written in 1854, shows how early and how firmly he had grasped the principle of evolution at that early time. That he should have been enchained by the new view was inevitable. The sciences were full of the raw materials of the inquiry, and evidence rapidly accumulated that a common process of unfolding transformation may be traced through all orders of phenomena. It was while writing the "Psychology" that Mr. Spencer first reached the conviction that evolution is a universal law of the course of nature. So vast and so pregnant an idea could not fail to have an all-determining influence upon his future course of thought. He saw that the scientific elucidation of this grand generalization, the discovery of the causes and conditions of the universal process, and the comprehensive application of the principle to the reor-

ganization of knowledge, must be the next great step in the progress of modern ideas. The import of the new view could hardly be exaggerated. Hitherto the unity of nature had been a speculative conception favored by the tendencies of science, but not resulting in any valid unification of knowledge. An epoch was now reached by the recognition of a demonstrable, all-unifying, objective law, capable of bringing the great divisions of science into closer co-ordination, and a more intimate mutual dependence. This made possible a philosophy of nature based upon the sciences, and to the working out of such a scheme of thought Mr. Spencer devoted all the powers of his mind. His qualifications for the task were eminent. His encyclopedic acquisitions, his remarkable power of analysis, his capacity of organization and generalization, declared by the "Saturday Review" to have been unequaled in England since Newton, prepared him to engage upon a great intellectual undertaking which he was himself the first to conceive and to project, and he resolved to work out a philosophical system of thought constructive and synthetic in its predominant character, and embodying the principle of evolution as its central and controlling conception.

Mr. Spencer entered upon this extensive project in 1858 by drawing up a scheme designed to occupy seven volumes and to contain a fundamental exposition of the proofs and principles of the theory of evolution, a broad application of it to the laws of life, of mind, and of human society, and finally to ethical science by showing the bearing of evolutionary doctrine upon the regulation of human conduct—the whole to constitute a systematic philosophy of evolution. His method was then mature, but upon further consideration the scheme was amplified in 1859 to ten volumes, and embodied in a prospectus for publication, which presented the course of the elucidation in detailed order of logical dependence under thirty-three consecutive divisions, and which referred to various extended tracts of the general investigation already written and published. This prospectus was printed in March, 1860, and has been adhered to, with no essential deviation, in the subsequent carrying out of the undertaking.

Now, in any critical estimate of Mr. Spencer's original contributions to the progress of knowledge, it is of the first importance to bear distinctly in mind the time at which they were matured. For this purpose we are closely concerned with his *status* as a thinker in 1858, as recognized by men of the highest ability while yet the general public knew nothing of him. There is evidence upon this point that must not be overlooked. When Mr. Spencer had elaborated the first programme, and resolved to execute it, he had at once to meet the primary difficulties of self-support and of publication. Thinking there might be some Government place of light duty and small emolument which he could consistently fill, and still have leisure for his labors, a few friends were consulted, and they gave him letters designed to be published and to favor his application. But Mr. Spencer gave up the plan and never printed them, and the use now made of them is by no consent of his. These letters were from John Tyndall, J. S. Mill, George Grote, T. H. Huxley, R. G. Latham, J. D. Hooker, and A. C. Fraser. Their joint import was that Mr. Spencer was a man of remarkable endowments, eminently qualified to do a great intellectual work, which would be an honor to the nation and a lasting service to mankind—a work like that of Bacon, although more arduous and difficult, owing to the vast accumulation of knowledge in modern times. One of the most distinguished of the writers said:

"I am glad to have an opportunity

of expressing my sense of the value which attaches to the writings of my friend Mr. Herbert Spencer, and of the high estimation in which I, as a practical man of science, hold his speculative labors.

"Founded as it is upon the accurate observation of facts, science would soon stagnate if the co-ordination of its data did not accompany their accumulation; and I can conceive nothing that would give a more vigorous impulse to the progress of science than the promulgation of a modern Novum Organon adapted to the state of knowledge in these days, and showing the unity of method of all science, and the mutual connection and interdependence of all forms of acquisition.

"I can not testify more strongly to my estimation of Mr. Spencer's abilities than by expressing my belief that, if health and moderate leisure be granted him, he will very satisfactorily perform this necessary piece of work for us. And I base my conviction not so much upon a knowledge of Mr. Spencer's works (though I could amply justify it from them), as upon that intimate acquaintance with himself which it has, for some years past, been my privilege to enjoy."

The eminent and responsible pledges thus tendered twenty-five years ago of Mr. Spencer's preparation to enter upon a great intellectual undertaking for the advancement of human knowledge have now been amply redeemed. Seven volumes of the "Synthetic Philosophy" have been given to the public, have been translated into various languages, and are recognized by the best minds as authoritatively representing a new epoch of thought, and as taking rank among the monumental works of the century. Though it may seem useless to quote authorities in confirmation of this statement, yet they have so important a bearing upon our present purpose that we must be excused for citing a few expressions testifying to the position of the man as shown by the character of his accomplished work.

Dr. Masson, of the Edinburgh University, spoke several years ago, in one of his books, of Spencer as the rising power in British philosophy; and G. H. Lewes, in his "History of Philosophy," declared "that no thinker of finer caliber had appeared in England." Professor Jevons, in his "Principles of Science," ranks the works of Spencer as in their influence among the most important that have appeared since the "Principia" of Newton. Dr. J. D. Morell, author of the "History of Philosophy," testified to Spencer's "extraordinary power of analysis and generalization," and Dr. Fairbairn recently declared that to conceive such a system as Spencer's "is in itself an education to an age." Professor Huxley remarked before the Royal Institution that "the only complete and systematic statement of the doctrine (evolution) with which I am acquainted, is that contained in Mr. Herbert Spencer's 'System of Philosophy.'" Mr. J. S. Mill has referred to his "encyclopedic knowledge"; Mr. Darwin spoke of him as "our great philosopher"; H. W. Beecher as "king of the thinkers of this age"; President McCosh recognized his "giant mind," and President Barnard speaks of him as "not only the profoundest thinker of our time, but the most capacious and the most powerful intellect of all time."

These emphatic declarations regarding Spencer's genius and position as evinced by the greatness of his work must be construed as applying to what he had really achieved in 1858–'59. It is not that his works stand to-day confessed in their supereminence, but that he was before all other men in arriving at the views they contain. Evolution has now become a commonplace of thought; it was the guiding principle of Herbert Spencer's intellectual labor thirty years ago. While yet the doctrine was scouted as a chimera by one half the world, and execrated as an abomination

by the other half, there was with Mr. Spencer no slightest question of its truth, the evidence for it being to him overwhelming and irresistible on every hand. While a few scientific men were giving to it a reserved adhesion, or testing it in special directions, Mr. Spencer was reconstructing the sciences by its guidance, and building a philosophy out of its principles. In any attempt to appraise his intellectual rank, we are bound to remember the originality and the priority of the labors it is now so easy to applaud. When it is a question of grading the searcher after truth, it makes a profound difference whether he is a pioneer or a follower; and it is but naked justice to Mr. Spencer to recognize that he had worked out the grand doctrine of evolution in systematic completeness as now formulated and accepted before Mr. Darwin had published a word of his important contributions to the subject.

Clearly, then, the action taken by the French Academy is discreditable to its intelligence and to its impartiality. By all the equities that should control it in the discharge of its self-assumed office of rating the intellectual services of eminent men, the name of Herbert Spencer ought long since to have been enrolled among the first in honor. By its culpable tardiness its belated verdict is alike superfluous to the recipient and to the world which long ago formed its judgment of the rank of this philosophical thinker. And when at last the decision comes, it betrays a misconception of the case, which may be fitly characterized as a blunder, while only the following sorry apology can be offered for it. It is well known that the French are behind the world in their appreciation of the doctrine of evolution. The French mind has never recovered from the warp it received half a century ago in getting committed on the wrong side by the overshadowing genius of Cuvier, whose brilliant rhetorical triumph over Geoffroy Saint-Hilaire, in the walls of the Academy itself, strongly biased the national thought in relation to this subject. The *savants* of France may therefore be not very competent judges of the foreign contributions to the knowledge of it. But surely they should have known better than to offer Herbert Spencer the successorship to "Tappan, of Detroit!" In what way this gentleman ever got into the French Academy, let those explain who can; but certainly, if the place was suited to him, it is not such as should have been proffered as an honor to the most commanding intellect of the age.

---

## LITERARY NOTICES.

NOTES OF TALKS ON TEACHING. Given by FRANCIS W. PARKER, at the Martha's Vineyard Summer Institute, July 17 to August 19, 1882. Reported by LELIA E. PATRIDGE. New York: E. L. Kellogg & Co.

THE normal schools all over the land have for the past twenty-five years been sending out graduates whose mission it has been to replace the old rote-system of lesson-learning by methods better adapted to the minds of children. We commend this book to that great body of earnest teachers. It contains a series of twenty-five full, clear, and much-needed expositions of the principles that underlie primary and grammar school teaching. The first half of the volume is devoted to lectures, or "talks," as they are called, upon teaching children to read, to spell, and to write. There are nine further "talks" upon teaching composition, numbers, arithmetic, geography, and history. Then follow a chapter upon examinations, another upon school government, and another upon moral training.

It is said, by some of our leading teachers, that the noise about Colonel Parker and the "Quincy System" is largely due to the prominence of his trumpeters—the Adamses. And, no doubt, many willing learners will ask: "Is there really anything new in Colonel Parker's teaching? Have we not, for a generation, been using identical methods?" We reply that this book cer-

tainly contains a great deal that we have not before seen in the literature of school-reform. Candid readers, familiar with current school ideals and practices, will see, we think, that Colonel Parker is working from a stand-point of his own, and that his view of the situation is not the generally recognized one.

The fashion of modern educational reformers has been to exalt "method" above all other things. Normal pupils have been trained early and late in *methods* of teaching. To the acquirement of method they have given long practice, under sharp criticism. And the practical issue of all this drill has too often been a kind of teaching which has at once fallen to the level of dead routine. The method, mechanically acquired, has been mechanically applied. Colonel Parker evidently sees this. With him methods are nothing without competent teachers; and competent teachers evolve their own methods. The "talks" in this volume are mostly of the underlying psychological principles that should shape methods, and rarely of special practices. He reiterates his warning to teachers against *imitation*. Teaching, with him, is a vital intercourse between the *mind* of the teacher and the *mind* of the scholar. It is in his greater reliance upon the guidance of principles, and the personal activity of the teacher, working on his own hook independently of anybody's method, that Colonel Parker's claim seems to us to consist.

He has unusual insight into mental phenomena. He is a student of psychology, with an intuitive tendency to seek the causes of things. Further than this, he has strong sympathy with childhood, and these combined traits give originality to his work as a teacher. They make him a reformer of the reformers. He sees through the barren formulas and absurdities that have frequently replaced the old-fashioned school routine.

His sense of the inanity of prevailing practices is often seen in these pages. For instance, in speaking of so-called analytical teaching, he gives the following familiar example of recitation in arithmetic:

*Teacher.*—"If one apple costs three cents, what will four apples cost?"

*Child.*—"If one apple costs three cents, four apples will cost four times as many cents as one apple will cost. Therefore, four apples will cost four times three cents. Four times three cents are twelve cents. Therefore, if one apple costs three cents, four apples will cost twelve cents."

Colonel Parker adds: "I think I have not put in all the words that can be put into this complex and useless explanation. If the previous work has been correct, all the child needs to say is, 'twelve cents,' and go on performing a dozen examples, instead of agonizing over this one."

By "previous work" Colonel Parker means the early study of numbers, which should be "by bringing the mind to bear directly upon the relations of things. . . . As well might we try to teach the facts in botany without plants, in zoölogy without animals, form without form, and color without colors, as to teach number without numbers of objects. All primary ideas of numbers and their relations must be obtained immediately through the senses, and by their repeated limitations as numbers of things, as to how many. . . . From repeated tests, given by myself and by teachers under my supervision, the average child of five or six years of age does not know three when he enters the school-room. . . . Ability to count," says Colonel Parker, "must not be confounded with the knowledge of numbers. Knowing a number is, first, knowing the equal numbers that make it up; second, the equal parts of a number; and, third, any two unequal numbers in a number and any two unequal numbers that make it up. This applies to numbers from one to twenty, and is learned by experiments with things. I have tried during the last eleven years to teach numbers to little folks, and I have never succeeded in teaching, nor have I seen ten really taught, during the first year. By using language without regard to what it expresses, fifty or one hundred may be taught; i. e., the child, by unceasing drill, may repeat gibberish that seems to be knowledge to the casual observer. Ask him to verify his statement by showing the real relations among things, and you find he has been repeating an unknown language."

Colonel Parker's criticisms upon much that goes as object-teaching are equally trenchant and thorough-going. With him,

education is idea-growth. He understands the conditions of this growth, and he knows that the first business of a teacher should be to learn these conditions. So far as we know, the subject of mental growth is not put on this footing in our training-schools, nor are our teachers tested by any such standard. But the circulation of such books as this will hasten the time when the teachers of children will be required to know something of the laws that govern their mental development.

AN ADDRESS ON THE FIFTIETH ANNIVERSARY OF THE CLASS OF 1832, parts of which were read at a Class-Meeting at Union College, June 27, 1882. By CHARLES E. WEST. Brooklyn, N. Y.: Tremlett & Co.

THIS is a volume of unusual interest of its kind. There is of course much in it of local and personal import that will be chiefly prized by the parties in most intimate relation with the scene of the history, but we have found even this portion of Dr. West's monograph very entertaining. We call attention to it here, however, on account of the admirably executed survey of scientific progress in its main departments which has taken place during the fifty years which have elapsed since the organization of the "class of '32." From his wide familiarity with the labors of scientific men, and his clear appreciation of the great drifts of modern thought, Dr. West was well prepared to perform the duty that devolved upon him in sketching the great changes of the last half-century, and he has done it in a most able and attractive manner.

THE LIFE OF JAMES CLERK MAXWELL, with a Selection from his Correspondence and Occasional Writings, and a Sketch of his Contributions to Science. By LEWIS CAMPBELL, M. A., LL. D., and WILLIAM GARNETT, M. A. London: Macmillan & Co. Pp. 662. Price, $6.

No stronger individuality has appeared in recent English science than that illustrated by the present biography. Clerk Maxwell was a man of undoubted genius, as a mathematical physicist among the very ablest, and withal original, versatile, and eccentric. He had a strong sense of humor, and mixed wit, fun, pictures, and poetry, with much of his speculation in science. He was affectionate and interesting as well as adventuresome and refractory as a boy, and was always unconventional, quaint, and simple in his ways. He dipped deeply into logic and metaphysics when in college, and the tendency to subtile speculation is exemplified in all his scientific works. His life furnished much material for the pen of the biographer, and the volume is graphic, spicy, and very readable. Much of it consists of his correspondence and previously unpublished notes, while the course of his mental development is well delineated, and the importance of his researches is clearly presented. He had a very profound admiration for the genius of Faraday, and perhaps his own most important work consists in the mathematical development of physical ideas concerning the constitution of matter, the germs of which are found in the insight of the great electrician. Professor Maxwell's character is thus summed up by the writers of the present volume:

> Great as was the range and depth of Maxwell's powers, that which is still more remarkable is the unity of his nature and of his life. This unity came not from circumstance, for there were breaks in his outward career, but from the native strength of the spirit that was in him. In the eyes of those who knew him best, the whole man gained in beauty year by year, as son, friend, lover, husband; in science, in society, in religion; whether buried in retirement or immersed in business, he is absolutely single-hearted. This is true of his mental as well as of his emotional being, for indeed they were inseparably blended. And the fixity of his devotion, both to persons and ideas, was compatible with all but universal sympathies and the most fearless openness of thought. . . . That marvelous interpenetration of scientific industry, philosophic insight, poetic feeling and imagination, and overflowing humor, was closely related to the profound *sincerity* which, after all is said, is the truest sign alike of his genius and of his inmost nature, and is most apt to make his life instructive beyond the limits of the scientific world.

OLIVER WENDELL HOLMES, POET, LITTÉRATEUR, SCIENTIST. By WILLIAM SLOANE KENNEDY. Boston: S. E. Cassino & Co. Pp. 356.

No doubt the rampage for personal gossip, displayed alike by our newspapers and magazines, is largely shared also by biographical writers who enter upon the delineation of many lives before the life has ceased. As to the gossip, it is of course but an index of the public appetite, and, as to its untimeliness, that must be held as timely which is sufficiently wanted. That

we should have a virtual life of Holmes while he is yet among us and busy as ever, seems to us as far as possible from being objectionable.

And certainly no man ever had a greater temptation for working up a personal career to the edification of all contemporaries than the writer of this book. His materials are abundant and attractive, to many they will be fresh, and to all entertaining. The account of the early life of Dr. Holmes we have found very pleasant and satisfactory, and the information about his various publications interesting; the eulogy is of course inevitable, and the criticism more or less passable. For Mr. Kennedy must also favor us with his estimates of the genius, performances, and opinions of the author he has taken in hand. But his judgments, if not very valuable, can not be much misleading, because everybody has read these fascinating books, and each one can make up his own mind as to their merits. On the whole, however, we confess ourselves much obliged to Mr. Kennedy for his agreeable volume.

METHODS OF SOCIAL REFORM, AND OTHER PAPERS. By W. STANLEY JEVONS, F. R. S. New York: Macmillan & Co. Pp. 383. Price, $3.

THIS volume consists of various articles contributed within the last few years by Dr. Jevons to the reviews on a variety of social subjects, and which have been collected by his wife for those who desire to possess them in a permanent form. It was the intention of Dr. Jevons to reissue them himself, and before his untimely and lamented death he had already revised two of them, "Experimental Legislation and the Drink-Traffic," and "Amusements of the People." The remainder are reprinted just as they were originally written.

It is unnecessary to commend the work of this able writer. His several treatises on philosophical subjects are of excellent repute. But the present volume, while quite miscellaneous in its topics, probably represents his latest views on important practical questions of a social character. They are marked by clearness and moderation, and will be found full of sober reflection upon questions too frequently treated by extremists in visionary and extravagant ways. Much of Dr. Jevons's criticism deals with the social condition of things in England, and is designed to bear upon special practical reforms, but the discussions are always carried on with reference to principles that are not without application in other countries.

INQUIRIES INTO HUMAN FACULTY AND ITS DEVELOPMENT. By FRANCIS GALTON, F. R. S., author of "Hereditary Genius." New York: Macmillan & Co. Pp. 387. Price, $3.

MR. GALTON, as is very well known, has taken up the systematic study of human character from the most modern point of view, and, pursuing it in the light of the doctrine of evolution, has carried out a course of experimental inquiries ingenious in conception and fruitful of many new conclusions. With his numerous papers contributed to learned societies and to the periodical press, scientific readers are familiar; these, which are of a varied character, he has now revised, extended, reduced to considerable unity of method, and published in the volume before us. Mr. Galton's researches are characterized by great subtilty of perception, a remarkable insight into the elements of human character, and a surprising skill in pursuing his fertile suggestions to verification by experimental tests. He has done much, more indeed than any other investigator, to bring the elements of research respecting individual characteristics into quantitative and statistical form, so as to favor accuracy of inductions. If a more technical title had been admissible, the present work might have been called a treatise on anthropometry—the measurement of the traits of human nature. It is through the bodily correlations of intellectual and emotional effects that this experimental method becomes possible, and all Mr. Galton's studies, although they deal largely with psychical phenomena, are made upon the basis of organic conditions and physical characteristics. The subject of composite portraiture, to which Mr. Galton has given much attention, and which, indeed, he has created as an important branch of investigation, is fully treated in this volume, the result of his latest methods being given and pictorially illustrated, while graphic and diagrammatic resources are extended to other

subjects of inquiry. The book is most interesting throughout, full of novel and acute suggestions and practical conclusions of varied applicability. The chapters upon "Variety of Human Nature," "Anthropomorphic Registers," "Mental Imagery," "Enthusiasm," "Influence of Man upon Race," "Early and Late Marriages," and "The History of Twins," may be mentioned as of especial interest, although the whole work richly deserves the critical attention of all the scientific students of human nature.

WEALTH-CREATION. By AUGUSTUS MONGREDIEN. With an Introduction, by SIMON STERNE. New York: Cassell, Petter, Galpin & Co. Pp. 308. Price, $1.25.

THE author is well known as a writer of unusual clearness on questions of political economy; as a practical business man possessing the happy faculty, which does not always exist in men engaged in trade, of considering these questions by reference to their fundamental principles, and in the light of a strictly correct reasoning. The predominant ideas of his work are that the abolition of war and the establishment of unrestricted freedom of trade are the essential conditions to the creation and even diffusion of the largest wealth and prosperity among nations. In Mr. Sterne's introduction is given a review of the history of tariff legislation in the United States, with facts showing that our manufacturing industries and other interests have enjoyed the greatest degree of relative prosperity during the life of tariffs laid for revenue only; that while from 1850 to 1860, with such a tariff, the capital invested in manufactures and the product of the manufactories doubled, from 1860 to 1870, under the war tariff, they did no more; and from 1870 to 1880, under the same tariff, they increased only twenty-five per cent.

ALCOHOLIC INEBRIETY, FROM A MEDICAL STAND-POINT, WITH CASES FROM CLINICAL RECORDS. By JOSEPH PARRISH, M. D. Philadelphia: Blakiston, Son & Co. Pp. 185. Price, $1.25.

DR. PARRISH has performed an excellent and much-needed service in the preparation of this volume. That both the moral and political agencies have failed to do what was expected from them, in putting an end to the evils of intemperance, is now but too well known. Henceforth less sanguine expectations must be entertained as to what can be really accomplished, and different means resorted to for the purpose—chief among which will be the diffusion of sound scientific information in regard to the subject of which this volume on alcoholic inebriety is an example.

The point of view from which the work is written is thus stated by the author: "From the ordinary and popular outlook, inebriety corrupts a wide range of both public and private morals, and is so interwoven with the affairs of life, both domestic and civil, that it is looked upon as the chief factor of crime, of insanity and many other diseases, and as a general disturber of all that should be cherished as valuable in the life of individuals and of the community. Efforts have been put forth to arrest its progress, if not to apply a radical remedy for its evils, to which the pulpit, the press, the platform, and the ballot, have all contributed a share of influence, till the land is covered with organizations having for their standard the doctrine of abstinence and prohibition. Taking half a century ago as a starting-point, the growth of the temperance sentiment of the country has been marvelous, and to-day, *simply as a sentiment*, it holds a prominent and commanding position; and yet we are confronted with the discouraging statement that dram-drinking and drunkenness are on the increase."

"From another outlook, not so popular, because not so familiar, another view may be had, which, though more limited in its scope, is none the less important, because it reveals the causal beginnings from which flow the results that are recognized as intoxication. As yet this new field has not been explored as it might have been, and as the gravity of the subject demands, notwithstanding it discloses the remote causes of inebriety, and indicates the remedial course to be followed in dealing with it. This is doubtless partly due to the fact that the new line of research is, in a degree, technical and scientific, and the people are not disposed to go behind what they see in the inebriate and his surroundings, to attempt to penetrate tissues, and search

after forces with which they are not familiar."

It has been the purpose of Dr. Parrish to treat the principles of his subject from the foregoing point of view as a physician interested first of all in the nature, causes, and treatment of disease. If alcoholism is a disease involving organic perversion and morbid physical action that has become chronic, it is of but little use either to exhort or pledge men against its effects, or even to invoke the law for the suppression of intemperance. Diseases must be treated in conformity with natural laws, and by men who understand what they are. Dr. Parrish takes up the subject of inebriety in its aspects of vice and crime, and with reference to the various abnormal manifestations of conduct in inebriates. The subject of heredity in alcoholic intemperance, and the relations of inebriety and insanity, with the questions of asylums for these classes, are considered. The chapters on "The Inebriate's View," "How to deal with Inebriates," "The Psychology of Inebriety," and "The Effects of Different Alcohols," are practical discussions of the subject which ought to be widely disseminated. It should be stated that a large number of cases are cited in the work, illustrative of the phenomena and varied effects of intemperance, under its several aspects of vice, crime, and disease.

CATALOGUE OF PUBLICATIONS OF THE SMITHSONIAN INSTITUTION, 1846 TO 1882. By WILLIAM J. RHEES. Washington: Smithsonian Institution. Pp. 328.

THE series of "Smithsonian Contributions to Knowledge" was begun in 1848, and now comprises twenty-three volumes in 4to, with 119 articles. The "Smithsonian Miscellaneous Collections," begun in 1862, embraces twenty-three volumes in 8vo, with 122 papers. The annual reports are represented by thirty-five volumes, which include much general matter of interest. Other series are the "Bulletins of the National Museum," of which twenty, aggregating 3,103 pages, have been published; the "Proceedings of the National Museum," which are sent out by the sheetful of 16 pages, and are at present represented by four volumes of 2,221 pages; and the volume of the "Reports of the Bureau of Ethnology," 638 pages imperial 8vo. The whole number of publications is 478. The names of the articles and the names of the authors are given alphabetically in the catalogue. No copyright is taken out by the Institution on its works, but acknowledgment is expected to be made of the use of them. All works that are in print can be obtained at cost price; and a price-list is printed in connection with the catalogue.

THE LEADING MEN OF JAPAN. With an Historical Summary of the Empire. By CHARLES LANMAN. Boston: D. Lothrop & Co. Pp. 421. Price, $2.

THE first part of this volume is devoted to biographical sketches of modern Japanese statesmen, authors, and scholars, largely those who have contributed in a greater or less degree to the bringing about of the late reforms in the empire. The materials for the sketches are, of course, derived from native sources, and much of the matter appears to be also; for it has a terseness, a richness, and a home flavor like those of the works of Japanese art that an American writer working up the sketches in his own way could never have given. All the more credit to Mr. Lanman for preserving this flavor, for it is one of the most attractive and delightful features of the book. In the second part are given excellent accounts, historical and descriptive, of the Japanese Empire, and of Corea—so lately the forbidden land; to all of which is added a bibliography of works on Japan.

THE BUILDER'S GUIDE, AND ESTIMATOR'S PRICE-BOOK. By FREDERICK T. HODGSON. New York: The Industrial Publication Company. Pp. 331. Price, $2.

THIS work is chiefly intended to assist the builder or contractor in making estimates of the cost of work he is about to undertake, by bringing before him the details he must look after, and their approximate cost. It is also useful to the person about to employ a builder or contractor, or who intends to execute his own plans. It includes a compilation of the current prices of all kinds of building materials in their details, of worked materials, and of labor, with building rules, data, tables, and useful memoranda, and a glossary of architectural and building terms.

FIRST-YEAR ARITHMETIC-TEACHER'S MANUAL, AND FIRST-YEAR TEXT-BOOK. By JAMES H. HOOSE, A. M., Ph. D. Syracuse, New York: C. W. Bardeen. Pp. 156. Price, 35 cents.

THIS work is based upon Pestalozzi's system of teaching elementary numbers, and is designed for pupils in the first grade, or first year of public schools. It appears to have grown out of work that was accomplished by teachers with pupils of the grade for which it is designed, and to be in effect simply a transcription of the record of that work as kept by the teachers from day to day, for application to other classes. By it, it is claimed, pupils may learn to compute numbers with accuracy and readiness, without a slate; to express themselves with facility and intelligence in the forms of arithmetical language; and to think patiently, vigorously, and accurately, and have a becoming confidence in their own powers.

ASTRONOMY CORRECTED. By H B. PHILBROOK, Counselor-at-Law. New York: John Polhemus. Pp. 55.

THIS little volume, says the author, "is respectfully submitted to the reading world, in order to remove the errors that have so long deluded mankind in reference to astronomical problems." These "errors" relate to the creation and the causes of the motions of the solar system, to Laplace's nebular hypothesis, and Newton's gravitation. It is not new to have the law of gravitation assailed, nor is it entirely novel to have the portion in regulating the universe that has been assigned to it referred to the interstellar ether. Mr. Philbrook is, we believe, the first to tell us precisely how the ether acts.

LOWEST FORMS OF WATER ANIMALS. By N. D'ANVERS. New York: G. P. Putnam's Sons. Pp. 59. Price, 50 cents.

THIS is one of the "Science Ladders" series of illustrated natural history readers, the special purpose of which is to teach the great laws of the animal kingdom in language simple enough to be intelligible to every child who can read. It teaches what an animal is and what protoplasm is, and describes the rhizopoda, sponges, infusoria, hydras, medusæ, sea-anemones, coral, polyps, polyzoa, and "some tiny creatures with water-works."

COMPENDIUM OF THE TENTH CENSUS, JUNE 1, 1880. Washington: Government Printing-Office. Part I, pp. 924; Part II, pp. 847.

THE scope of the census of 1880 was greatly enlarged, and its machinery was much changed from that under which the previous censuses were taken. The information collected by it has been much more extensive, more varied, and presumably more accurate than has been gathered for any other decade in the history of our country. Opportunity was given to begin the inquiries in departments admitting such anticipation, several months before the first of June, and thus to give a more careful and exhaustive character to the investigation; and the work of making the enumerations was given to persons especially appointed for it, and not to officers who already had other duties. Except as to churches, libraries, and private schools, the statistics of which have been delayed in compilation, the tables embraced in the "Compendium" touch all the general classes of statistics which will be embraced in a more detailed form in the more extended publication of the series of quarto volumes. Part I contains the statistics of population and agriculture; Part II, those of manufactures; power used in manufactures; mining, railroads, steam-craft, canals, telegraphs, and telephones; occupations; fisheries; foreign parentage; areas, dwellings, and families; Alaska; life-insurance; fire and marine insurance; valuation and taxation; public indebtedness; newspapers and periodicals; public schools; illiteracy; defective, dependent, and delinquent classes; and mortality.

GEOLOGICAL SURVEY OF NEW JERSEY. Annual Report of the State Geologist for 1882. By GEORGE H. COOK. Camden, New Jersey: F. F. Patterson. Pp. 191, with Map.

THE topographical survey has been continued over 480 square miles, chiefly in the highland country of the northern part of the State. The whole area covered by this survey up to the present time is 1,740 square miles. Progress is also reported of the United States Coast and Geodetic Survey, which, when completed, it is hoped in the next season, will cover 5,326 of the 7,576

square miles of the State. The report of "Geological Work in Progress" includes an extensive notice of the Red Sandstone district with its trap ridges, which is a marked local feature, with accounts of the eruptive rocks of Sussex County, iron-mines and mining industries, plastic clays and their uses, and shore-changes. The plastic clays are worthy of especial attention, for they have been found capable of extensive application, particularly for furnishing terra-cotta building material and architectural ornaments, and promise to become most important elements in the resources of New Jersey. The "sea-side developments," or growth of summer resorts now in course of rapid expansion, are also noticed, with some account of climatic peculiarities and of agricultural development in Southern New Jersey. A chapter on drainage is illustrated with a convenient map of the water-sheds. The resources for water-supply and the character of the water are considered, whether the supply is derived from lakes and rivers or wells, dug, driven, and bored; and the water-supplies of the larger towns and several important wells are described. The map accompanying the report has been corrected up to date.

ANNUAL REPORT OF THE CHIEF SIGNAL-OFFICER TO THE SECRETARY OF WAR, FOR THE YEAR 1880. Washington: Government Printing-Office. Pp. 1,120, with 119 Charts.

THE organization and objects of the Signal-Service department have been often set forth. Its chief purpose is to train a corps of officers competent to correspond by signal and give speedy and effective service in times of war and in emergencies. For that purpose primarily the training-school is kept up at Fort Whipple, Virginia, where officers are drilled for Signal-Service work. Incidentally, the service makes its value known in a variety of ways, and is the agency employed by the Government to secure the reports and forecasts of the weather. It had in operation, during the year of the present report, in the United States, 247 stations, and was receiving daily telegraphic reports from 189 stations in the United States and other countries. The net-work of its stations extends to the Atlantic and Pacific coasts and over the intervening territory. "Sunset stations" have been established at a number of places, where meteorological indications are gathered from the appearances at sunset, and with the aid of the spectroscope; and the officers at these stations have acquired an accuracy in forecasting the local weather twenty-four hours in advance, the degree of which is represented by a maximum percentage of $89\frac{3}{10}$ for the regions west of the Mississippi Valley, and $82\frac{8}{10}$ for the region east of the eastern bounds of that valley. The report is filled with masses of detail and station reports.

THE JEWELERS' CIRCULAR AND HOROLOGICAL REVIEW, March, 1883. D. H. HOPKINSON, Editor and Proprietor. New York. Pp. 32–lxxxviii. Price, $2 a year.

A MOST pleasing and flattering illustration of the prosperity and the artistic taste of the fraternity of jewelers and silversmiths in the United States. The literary department comprises thirty-two of the finely printed, large quarto pages, and is occupied with articles of special interest to the fraternity and of general interest to many others; among them we notice a part of a series on the elaboration of gold and silver, and a kind of "Notes and Queries," under the title of "Proceedings of the Horological Club." The other pages are occupied with the cards of manufacturers and cuts of their designs, many of which, it is hardly necessary to say, are exceedingly handsome.

THE PHYSIOLOGY OF PROTOPLASMIC MOTION. By TH. W. ENGLEMANN, M. D., of the University of Utrecht. Translated by CHARLES S. DOLLEY, M. D. Rochester, N. Y.: Davis & Leyden. Pp. 40. Price, 50 cents.

LIVING protoplasm, says the author of this treatise, possesses, in many cases at least, as it appears to the assisted eye, the power of independent, rapid movement. The motion expresses itself in a change of form and arrangement of the protoplasmic mass, the volume of which apparently remains the same. It may also be produced artificially. The present paper records the results of continued, careful, and minute studies of the manifestations of protoplasmic motion in its various forms.

LECTURES DELIVERED TO THE EMPLOYÉS OF THE BALTIMORE AND OHIO RAILROAD COMPANY. By Professor H. NEWELL MARTIN and Drs. HENRY SEWELL, WILLIAM T. SEDGWICK, and WILLIAM K. BROOKS, of Johns Hopkins University. Baltimore: Baltimore & Ohio Railroad Company. Pp. 98.

THE Baltimore and Ohio Railroad Company maintains two reading-rooms for the men in its employ, but it had been observed that only a part of those for whom the rooms were intended availed themselves of them. Professor Martin suggested to President Garrett that the men who were not readers might be induced to attend free popular scientific lectures, and proffered the services of himself and his biological colleagues in the Johns Hopkins University. The lectures were delivered in February, 1882, before audiences of twice as many deeply interested hearers as were expected. They were on "How Skulls and Backbones are built," by Professor Martin; "How we move," by Dr. Sewall; "Fermentation," by Dr. Sedgwick; and "Some Curious Kinds of Animal Locomotion," by Dr. Brooks. They are popular in character and are published in their present form by the railroad company for free distribution among the men who heard them, and among others in its employ who were not able to attend them.

THE UNENDING GENESIS; OR, CREATION EVER PRESENT. By H. M. SIMMONS. Chicago: The Colegrove Book Company. Pp. 111.

A PLEASANTLY conceived and pleasant-tempered essay on the phenomena of nature in the light of the Biblical story of the creation, the purpose of which is to show that creation is not and is not to be a completed process, but one that is ever recurring, the object of continual renewals, and still as fresh and living in its repetitions of to-day as when it first began to operate.

PROCEEDINGS OF THE DAVENPORT ACADEMY OF NATURAL SCIENCES. Vol. III, Part III. 1879–1881. Davenport, Iowa: Published by the Academy. Pp. 130, with Four Plates.

THE volume which is completed by the publication of this part contains a large number of contributions on subjects of geography, geology, natural history, and antiquities, which speak well for the activity and intelligent zeal with which the members of the Academy perform their self-imposed work. Most of the papers record the results of local investigations around Davenport, which seems to be situated in a district of much scientific interest. Other papers concern the larger field of investigations opened by our rapidly developing Western Territories. The whole of the third part of the volume is occupied with the memorials and writings of the late youthful but devoted President of the Academy, Joseph Duncan Putnam, in whose death science evidently has suffered a great loss. Besides the memorial addresses and biographical sketches, its principal feature is the publication in full of Mr. Putnam's notes on the *Solpugidæ*—a family between the scorpions and the spiders—of North America.

PROPOSED ORDINANCE AND RULES AND REGULATIONS FOR PLUMBING, HOUSE-DRAINAGE, ETC., IN THE CITY OF PHILADELPHIA. As reported by the Committee of Twenty-one. Philadelphia: P. Blakiston, Son & Co. Pp. 13. Price, 20 cents.

THE "Committee of Twenty-one" consisted of plumbers, architects, physicians, and citizens, interested in sanitary matters. The plumbers, as a body, submitted their suggestions, and the architects did the same. The committee, guided by these aids and their discussions, elaborated the ordinance which, in the shape in which it is here presented, constitutes a valuable epitome of the essentials of sanitary plumbing and engineering.

"APPALACHIA," April, 1883. Vol. III, No. 2. Appalachian Mountain Club. Boston: W. B. Clarke & Carruth. Pp. 104. Price, 50 cents.

THE present number of this interesting journal contains an article on "Mountain Observatories," by Professor Pickering; a paper by Mrs. John Tatlock, Jr., on the "Variations of Barometric Measurements of Altitude with the Season"; descriptive accounts, from explorations, of the Twin Mountain Range, the Blue Hills (of Norfolk County, Massachusetts), the Mountains of Eastern Cuba, and Roan Mountain, North Carolina; reports of officers, and of the work of the Club; and proceedings of meetings. In the course of the past three years, the

names of forty-seven mountains, of which no published accounts existed, while many of them were wholly unexplored, and several even unnamed, have appeared in the lists of the club. Of these there now remain but thirteen of which no description has as yet appeared in "Appalachia." Prominent features of the work described in the present number are the exploration of the Twin Mountains, the construction of new paths to the summits of Mounts Madison and Adams, the expedition up the Wild River Valley and the east branch of the Pemigewasset to the summit of Mount Lafayette, and more restricted but hardly less interesting investigations.

AN OUTLINE OF QUALITATIVE ANALYSIS FOR BEGINNERS. By JOHN T. STODDARD, Ph. D., Professor of Chemistry in Smith College. A. G. Carley, Northampton, Mass. Pp. 54. Price, 75 cents.

STUDENTS in a well-equipped qualitative laboratory, who have the time of a competent instructor at their disposal, need little help from a text-book. Some small book containing the tests by which the several bases and acids may be detected, and the succesive steps of the system of analysis which the instructor deems the best, is a necessity. Professor Stoddard's book belongs to this class, and probably leaves more for the student to work out under the guidance of the instructor than any similar book yet published. Thus, no equations are given, it being a part of his method to require the student to write these, and to draw up analytical tables for himself. He also requires the devising of new methods of separation, thus introducing an element of original work.

THE ADVANCED QUESTION-BOOK. By ALBERT P. SOUTHWICK. Syracuse, N. Y.: C. W. Bardeen. Pp. 366. Price, $1.50.

THIS work includes in one volume the "Dime" question-books on general literature, general history, astronomy, mythology, rhetoric, botany, zoölogy, chemistry, geology, and physics, with complete answers, notes, queries, etc. While we should never think of using such books in recitation, or of encouraging a teacher who used them there, we can conceive that they are admirable as manuals for ready reference.

JOHNS HOPKINS UNIVERSITY STUDIES IN HISTORICAL AND POLITICAL SCIENCE. HERBERT B. ADAMS, Editor. VI. PARISH INSTITUTIONS IN MARYLAND. By EDWARD INGLE, A. B. Pp. 48. Price, 40 cents. VII. OLD MARYLAND MANORS. By JOHN JOHNSON, A. B. Pp. 38. Price, 30 cents. Baltimore: Johns Hopkins University. Price of the series, $3 for twelve numbers.

THE idea of this series is to bring together, in numbered monographs, kindred contributions to historical and political science, so that individual efforts may gain strength by combination, and become more useful as well as more accessible to students. The Studies will be published at monthly intervals, but not necessarily in separate form. The present essays relate to peculiar features in the political and social organization of the Maryland colony, quite different from those which distinguished the New England organization, a correct understanding of which may help to explain some things in the history and present condition of the State.

---

## PUBLICATIONS RECEIVED.

Van Loan's Catskill Mountain Guide. 1883. Catskill, N. Y.: Walton Van Loan. Pp. 122, with Maps. 40 cents.

"The Medico-Legal Journal," Vol. I. No. 1. Published at 55 Broadway, N. Y. Pp. 115. $3 a year.

Woman's Medical College of Baltimore. Announcement and Catalogue. Baltimore. Pp. 12.

Small-pox and Vaccination. By Professor S. E. Chaillé. New Orleans: New Orleans Auxiliary Sanitary Association. Pp. 28.

Record for the Sick-Room. Philadelphia: P. Blakiston, Son & Co. 25 cents.

The Upper University: A Syllabus of the Scheme and of the Sources of its Revenue. By Thales Lindsley. Pp. 25.

The Human Consciousness: A Syllabus of its Data and Inductions. By Thales Lindsley. Pp. 17.

Relief of Local and State Taxation through Distribution of the National Surplus. By Wharton Barker. Philadelphia: Edward Stern & Co. Pp. 28.

The Ores of Leadville. By Louis D. Ricketts, B. S. Princeton, N. J. Pp. 68, with Plates.

School-Books on Physiology and Hygiene. By Stanford E. Chaillé. New Orleans. Pp. 10.

Hero-Worship: Sermon by M. J. Savage. Boston: George H. Ellis. Pp. 11.

Saylor's Portland Cement. New York: Johnson & Wilson.

Legal Provisions respecting the Examination and Licensing of Teachers. Washington: Government Printing-Office. Pp. 48.

Edison Electric-Light Company, Eighteenth Bulletin. Pp. 40.

Resuscitated: A Dream of Existence after Death, etc. Sacramento, Cal.: Lewis & Johnston. Pp. 123. 75 cents.

A Revision of the Genus Clematis of the United States. By Joseph F. James. Cincinnati. Pp. 19.

Manifesto of the Communists. By Karl Marx and Frederick Engels. New York: Schærr & Frantz. Pp. 28. 5 cents.

The American Trotting-Horse. By Professor William H. Brewer. Pp. 28.

The Evolution of the American Trotting-Horse. By William H. Brewer. Pp. 6.

The Natural Cure of Consumption, Constipation, Bright's Disease, Neuralgia, Rheumatism, Colds, Fevers, etc. By C. E. Page, M. D. New York: Fowler & Wells. Pp. 274. $1.

Relations of Micro-Organisms to Disease. By William T. Belfield, M. D. Chicago, Ill.: W. T. Keener. Pp. 131.

Conflict in Nature and Life. New York: D. Appleton & Co. Pp. 488. $2.

Bacteria and the Germ Theory of Disease. By Dr. H. Gradle. Chicago, Ill.: W. T. Keener. Pp. 219.

A Treatise on Insanity in its Medical Relations. By William A. Hammond, M. D. New York: D. Appleton & Co. Pp. 767. $5.

Life and Language of William Cobbett, with his Grammar. By Robert Waters. New York: James W. Pratt. Pp. 272. $1.75.

A Tragedy in the Imperial Harem at Constantinople. By Leila-Hanoum. Translated from the French by General R. E. Colston. New York: W. S. Gottsberger. Pp. 299.

Atomic Creation and other Poems. By Cornelius P. Schermerhorn. New York. Pp. 200.

God Out and Man In. Replies to Robert G. Ingersoll. By W. H. Platt, D. D., LL. D. Rochester, N. Y.: Steele & Avery. Pp. 320. $1.50.

Hand-Saws, their Use, Care, and Abuse. By Frederick T. Hodgson. New York: The Industrial Publication Company. Pp. 96. $1.

Plant-Life. By Edward Step. New York: Henry Holt & Co. Pp. 218. $1.25.

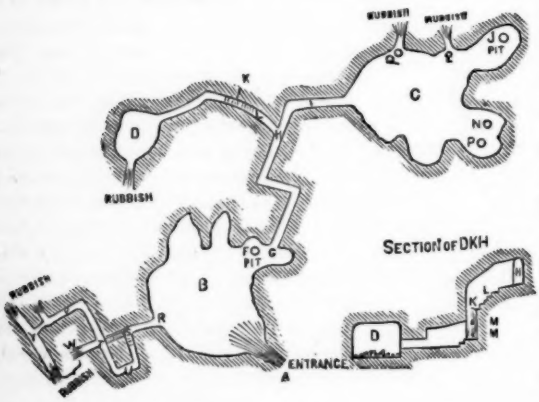
Manual of Taxidermy. By C. J. Maynard. Boston: S. E. Cassino & Co. Pp. 111.

Report of the Chief Signal-Officer, 1881. Washington: Government Printing-Office. Pp. 1296, with 69 Charts.

## POPULAR MISCELLANY.

**Nationalities in New York City.**—"The Impress of Nationalities on the City of New York" is the subject of a paper recently read by Mr. James W. Gerard before the New York Historical Society. The subject is a difficult one, for the impress is multiple and the population of the city is exceedingly heterogeneous. The characteristics of the old population were derived from the Dutch and the English. The Dutch brought with them the same spirit of independence that had characterized their forefathers and made them in Europe the pioneers of civil rights, and which had become national instincts. They also brought the spirit of toleration. During the English period the descendants of the Dutch settlers kept equal in the race with their English brethren in all matters of political and military action and enterprise. Their thrift and plodding industry and business sagacity have left their marks to this day. The French Huguenots, who came over during the period of the French persecutions, brought an improved cookery and a national gayety and courtesy that tended much to modify the habits and manners of our people. When we consider the principles and origin of the population thus formed, we can well imagine that the men were not afraid of the Revolution. "These were the descendants of the Dutch patriots, of Independents of the English fighting-stock under Cromwell, of French Huguenots, of banished Covenanters from Scotland, of soldiers of Monmouth's rebellion, and of men who had fought under the banner of both of the Pretenders." The Anglo-Saxon has, however, been the dominant type here, with which the Dutch and French have been absorbed by intermarriage; and the conditions of settlement and acclimatization, acting on the combined type, have produced a new, deviating race. To this may be added the infusion of the blood of the New-Englander, who is more conservative in character, more grave in temperament, and at the same time more enterprising and more persistent in action than the descendants of the Dutch and English settlers. This element, though Anglo-Saxon and formed into the local life, has still distinctive features. The deviation of the new race is apparent in its physical, mental, and perhaps in its moral attributes, and also in its lingual expression. Under the conditions of the new life, nerve-force and energy have been called upon, and have developed rapidly. The Irish and German nationalities, more recent acquisitions, have exercised great influence upon the city and its inhabitants. New York endures most of the evils and gets least of the advantages of immigration. The Irish, from their knowledge of our language, have exerted a stronger influence upon the city than the Germans, who keep more apart, and a greater proportion of whom travel westward or settle in districts of the city where they are separated from the rest of the population. But while the Dutch and the French have flowed into the general result, the Irish and Germans have been of too late introduction to have become factors in the formation of the general local character.

**Prehistoric Underground Chambers.**—The subterranean works called by the people of Poitou "gueriments" are little known, though the tradition of the country assigns their origin to prehistoric times. I purpose to describe one of these which I visited, with my brother, in 1878, and which may be regarded as a type of the whole series. The chalk of Beaumont, stretching south of Châtellerault, resembles a vast ants'-nest, so numerous are the galleries with which it is honeycombed. The one that I am about to describe is at a place called La Fuye, and is only a few hundred yards from the old Roman road between Colombiers and Jaulnay. We went down into a hole, A, overgrown with bushes, that looked very much like a fox's hole, and came upon a large hall, B, on which abutted the passages G and R. The passages are of about the height of a common-sized man, but less than two feet wide. They appear to have once been tightly closed by doors and fortified by beams. After going in about a hundred metres, and making a number of turns, I came to a sudden descent, and fell into the hole K (see the section D K H). When I came to myself, and was able to examine the place, I found that the narrow passage led to a steep ladder of five steps, L, at the end of which was the hole into which I had fallen, about six feet deep. Hence led another narrow gallery, which we explored with great difficulty, but at the end of which we came to the spacious chamber D, where we found a quantity of large bones, charcoal, and blocks of flint, and, by digging, a badly decayed piece of coarse pottery. Gallery E opened out from this passage, but it had become choked up. Returning, we climbed up the passage K with the aid of the foot-holes M M in the wall, and went through the gallery I, into the chamber C, which contained a number of circular pits, J, N, P, suggesting the form of a cistern, but they could not have been used to hold water. The galleries O and Q were choked up. Returning to the first chamber, and passing the half-filled pit F, we went by the corridor R into the galleries *s*, *u*, *t*, *v*, *y*, in which we remarked two tubes, pierced at *t* and *s*, so as to form a direct communication between W and B. The construction of all the "gueriments" is analogous to that of this one. They are cut in the rock itself, and consist of large chambers connected by narrow galleries, and present a striking similarity of aspect to those dwellings which insects hollow out in the trunks of trees. The openings of descending passages had been closed by trap-doors and fastened by wooden cross-beams. Niches in which lights could be placed were cut at convenient distances. Many "gueriments" communicated with a well; and, as some of the galleries have been wholly stopped up, at some more or less remote period in the past, the only entrance now is by the well. I have only visited three caves of this kind, but I know of a considerable number of them that can not be explored because of the presence of an excess of carbonic acid in them.—*Translated for the Popular Science Monthly from La Nature.*




[NOTE BY THE EDITOR OF POPULAR SCIENCE MONTHLY.—Strabo, in his accounts of the Siculi around Lake Avernus in Central Italy, says: "Ephorus assigns the place to the Kimmerioi, and says they lived in underground dwellings which they called *argillai*, and through certain excavated passages passed about to each other, and conveyed strangers to the oracle, which was constructed deep in the ground."]

**Musical Fishes.**—Cases of peculiar sounds being heard at sea and ascribed to fishes are not rare. Lieutenant White, of our navy, relates that, when at the mouth of a river in Cambodia in 1824, he and the crew of his vessel were struck by hearing extraordinary sounds, like a mixture of the bass of an organ, the ringing of bells, the guttural cries of a large frog, and the tones of an enormous harp, which they heard around the bottom of their vessel. The interpreter said they were produced by a troop of a kind of fish. Dr. Buist, in 1847, told of a party in a boat near Bombay, who heard sounds not unlike the others, which the boatmen said were produced by fish. Similar sounds were reported two years afterward as having been heard from beneath the water at Vizagapatam. Sir J. Emerson Tennent heard like sounds from the Lake of Batticaloa, in Ceylon, and the natives said that a shell made them. A correspondent of the "Field," in 1867, alleged that the vessel in which he was at Greytown, Nicaragua, was haunted at night by these sounds. A similar account, probably of the same occurrence, is given by Mr. Dennely, in "Nature" of May 12, 1870. Another correspondent of the "Field" told of sounds "produced by fishes" which he heard in the Tavoy River. A review of all the accounts shows that the sounds were nearly always heard in ships at sea, though Canon Kingsley once heard them at Trinidad from the shore; that they are most commonly heard in tropical regions, but sometimes in the temperate zone; that they have been noticed along an extensive line of coasts, American, European, and Asiatic, northern and southern; that they are invariably heard at night; and that they are most generally heard near the mouths of rivers. Dr. Dufossé, who has made the production of sound by fishes a special study, says that, while many fishes can make themselves heard, there is a great variety in the manner in which the noises are evolved. Sometimes they proceed from the movements or friction of the pharyngeal bones, or the vibration of the muscles of the swimming-bladder. In the latter way a gurnard produces nearly an octave of notes. The males of the genus *Ophidium* are provided with a drumming apparatus, consisting of bones and muscles developed in relation to the swimming-bladder. The sounds made by the *Umbrinas* of the Mediterranean have been heard from a depth of twenty fathoms.

**Action of Acids on Tin-Ware.**—Mr. Francis P. Hall reports the results of experiments on the action of vegetable acids—acetic, tartaric, and citric acids—on lead and tin. The results were rather negative in their tendency, and seem hardly to bear out the assertions that are made respecting the danger of lead-poisoning from tinned goods. The most danger is from the solder, and from the action of the acids on the tin itself. The corrosion does not appear to increase as regularly as is supposed with the strength of these acids; but it was found that corrosion, in the case of canned fruits, takes place very rapidly after the can is opened, so that a can when opened should be emptied at once. Mr. Hall's analyses of bright tin-plate failed in every case to show enough lead impurity to justify the charge of intended adulteration, even in the worst-looking ware from the five-cent stores. Terne plate, used for roofing, is known to contain large quantities of lead, but no one with his eyes open is ever likely to buy it for genuine tin. Tin-foil, which is used for enveloping various kinds of food, is in some cases pure tin, in other cases heavily adulterated. Specimens used for wrapping different kinds of compressed yeast were pure. The worst specimen (89·87 per cent lead) was embossed, and on a very fashionable cake of chocolate.

**German Explorations in Africa.**—The Germans claim the honor of having done the most after the English for the exploration of the interior of Africa. The trading posts of the Hamburg merchants on the east coast have long exercised a civilizing influence there. To German missionaries are due the first important discoveries that were made in that region, viz., the discovery of Mount Kilimanjaro by the missionary Rebmann, in 1848; that of Mount Kenia by the missionary Krapf, in 1849; and the execution of a map of the country, showing the Ukerewe Lake, by Rebmann and Erhardt, a work which provoked the English expeditions of Burton, and of Grant and Speke. Dr. Albert Roscher planned the ascent of

Kilimanjaro in 1859, but gave it up to seek for Lake Nyanza, and died in that attempt. Baron Claus von Decken, in the next year, climbed Kilimanjaro to the height of 8,360 feet, and ascertained the total height of the mountain (18,710 feet). Again, in 1862, he, with Dr. Otto Kersten, climbed the mountain to 14,160 feet, and determined its volcanic nature and its situation. Von der Decken was finally murdered by Somaulis, in his fourth expedition up the Juba River. Richard Brenner followed this adventurous traveler, and retraced his last journey. In 1875 J. M. Hildebrandt was sent out by the Karl Ritter *Stiftung* and the Berlin Academy of Sciences on an expedition to the mountain-region, which was fruitful in scientific results. Other important expeditions were made by Clemens Denhardt, in 1878, by Dr. Schweinfurth, and, more recently, by Gerhard Rolfs and Dr. Nachtigal. Lastly, Dr. G. A. Fischer, who took part in Denhardt's expedition, has gone out under the auspices of the Geographical Society of Hamburg for an exploration of Somauli-land and the Galla country.

**Brain-Health.**—In a lecture at Edinburgh, on "The Establishment and Maintenance of Brain-Health," Dr. J. Batty Tuke pointed out a certain class of influences acting for good or evil on the brain over which the individual had no control. They were those connected with his antecedents and bringing up. A man might be handicapped for life by the mistakes or faults of his ancestors; and, differently from the race-horse, he had to carry weight in the race of life according to his imperfections, not according to his advantages. In respect to this point, every child's future history depends upon the food it gets and on its surroundings, and much upon the mother, whether she be well and vigorous or the contrary. Of other food than mother's milk, the Scotch oatmeal-porridge and milk is a "typical" food, and the best. Tea should be condemned. In education, home influence should never be spared. To send a child away from the family influence into an atmosphere of necessarily strict discipline and routine should be the last resource of misfortune. The life of a child so placed is artificial, its individuality is endangered, and its experience circumscribed. Therefore, at all hazards, keep the child in the family, and send him no farther than to the day-school. One of the great causes of overstraining in early youth is the vicious system of offering prizes for competition. It deflects the mind of the child from the main aim and object of its study, and often defeats them. Our whole educational system tends too much in the direction of abstract facts and theories, and to produce a sort of brain-dyspepsia or indigestion; for the child's brain is not given time to assimilate the food it gets. Among women, idleness and ignorance are much more prolific causes of disease than overwork. It is not work, but worry, that kills the brain. The most highly educated and hard-working women the lecturer knew were eminently healthy. Breakdown from overwork does, however, occasionally take place, and the first really important symptom is sleeplessness. When that sets in there is cause for alarm. Headache also comes on; and, as soon as a child or young person develops continuous headache, work should be discontinued at once. Most men working in this department of medicine recognize that, if there is a hope of diminishing the amount of brain-disease, it is to be effected by preventive measures. The lecturer had therefore directed attention more especially to the transgressions of the father than to those of the son.

**Deformities due to School-Life.**—Dr. Dally read a paper at the Geneva Hygienic Congress on the "Deformation of the Body during School-Life." The researches of Dr. Chaussier, who found that only 122 out of 23,200 newly-born infants examined by him possessed abnormal peculiarities of any kind, indicate that children are, as a rule, straight when they start to school. The deformities which they exhibit at a later period may therefore be attributed to the enforced maintenance of one attitude for a considerable length of time. The various parts of the organism of youth are easily displaced, and, if the cause operates continuously, the displacement is liable to become permanent. Doctors were exhorted to pay more attention to the medical aspects of school-life.

**Some Peculiarities of Color-Blindness.**—Mr. R. Brudenel Carter defines color-blindness, in his Cantor Lectures on that subject, as incapacity on the part of the nerves of vision to respond to the stimulus which one of the three kinds of light is calculated to produce. It will help us to realize the nature of the defect to assume, which is not quite the case, that white light is composed of red, green, and violet in equal proportions and of equal luminosity; then to eyes which are incapable of seeing one of the colors, one third of the illumination of natural objects is extinguished, and the appearance the objects present is not that of their real color, but only of that fraction of their real color in which the two visible colors are combined in them. White is not white to the color-blind, but a mixture of green and violet to the red-blind, of red and violet to the green-blind, and so through the other shades and the other varieties of color-blindness. It is impossible to obtain an exact idea of what the color-blind see, except a person be examined who has one eye normal-sighted while the other eye is defective. Professor Holmgren has examined two such persons, one of whom was red-blind, the other violet-blind in one eye, with results tending to confirm what had been predicted on the subject in accordance with the Young-Helmholtz theory. The mistakes made by the color-blind in daily life are much less numerous and less remarkable than might have been supposed; so much so, that the recently acquired knowledge of the great prevalence of the condition has come as a great surprise to most of the world; and persons may live for years having the defect without knowing it till the fact is revealed by some unexpected test being applied in an unusual manner. The color-blind are seldom fully insensible to differences in the colors between which they can not distinguish critically. They learn by habit to perceive differences in the appearance of objects which are called by different color-names—difference it may be in shade, or in intensity of light—which they learn to associate with the color-names, and will so escape being caught. Men on railroads may thus learn to distinguish red from green lights by one of them being bright and the other dim, and may go for a long time without being found out. Their defect, however, will some day expose them, probably when they are least suspicious of its influence. It has been remarked that color-blind men regularly eliminate themselves from railway-service in the course of a few years, by a kind of unintelligent selection, so that they are never found among the old servants of any company. They get discharged for carelessness, or for drunkenness, for accidents which were really owing to color-blindness. It is evident from these considerations that no test of the color-sense can be wholly satisfactory that depends on calling the colors by their right names, for that becomes a matter of habit—not one that depends on the exhibition of differently colored lights, for the blindest know a difference, although not *the* difference, between them. Holmgren's variously colored worsteds, of about a hundred and fifty shades, which candidates are required to assort and match, afford the most satisfactory and a nearly perfect test.

**Cat-Lore.**—The origin of domestic cats is obscure, but seems by all accounts to fall somewhere within historic times. All the histories of ancient nations seem to go back to a time when they had no cats. M. Lenormant says that a wild cat was hunted and eaten by the Swiss lake-dwellers in the age of stone; but Africa, south of Egypt, appears to have been the cradle of the cat as a domesticated animal. Pussy appears in the middle-empire Egyptian monuments in the character of a retriever seated in the boat of the wild-fowl hunter, a circumstance indicating that those people had a strain that did not have as unconquerable an aversion to the water as our cats; and there have been cats, even in modern times, that could bring themselves up to diving after fish. The cat, like everything else, whether agreeable or horrible, was raised to the odor of sanctity in Egypt and became the emblem of the goddess Pasht, the Egyptian Diana. M. Lenormant believes, however, that this worship was comparatively late, and finds no trace of the animal among the monuments of the ancient empire. Under the earlier dynasties, Pasht was a lioness-goddess, and not till the twelfth dynasty, and the conquests in

the land of Cush, did the cat come to the front. We may therefore regard the cat as a Cushite animal, derived from the *Felis maniculata*, which was found wild in upper Nubia and the Soodan. The Egyptians carried their reverence for cats to what seems to us a ridiculous excess. If any of them voluntarily slew one of the sacred animals, he was punished with death; and Diodorus relates that a Roman soldier who had killed a cat could hardly escape the fury of the people. When a cat died in a house, the people shaved their eyebrows; and dead cats were embalmed and buried in the city of Bubastis, which was sacred to Pasht. According to M. Lenormant, the Egyptians still respect cats, and in Cairo serve up a copious banquet every day to the cats of each quarter, "in the court of the house of the cadi." The late introduction of domesticated cats among Semitic peoples seems to be proved by the absence of mention of them in the Bible. The Assyrians and Babylonians are said to have been equally ignorant of the animal. A lively discussion between Mr. A. S. Murray and Professor Mahaffy a few years ago, as to whether the Greeks had cats, seems to have resulted in an understanding that they had not. Their cat was a polecat or something else, and the Byzantine writers of later days seem to have been the first who gave its name to the modern cat. No Greek or Roman pictures or representations of the *mau* or "mew-cat" of the Egyptians are known, except one that M. Longpérier has found on a Tarentine coin struck shortly before the wars of Pyrrhus, and one on a lost post-Christian tombstone. The Indo-Aryans of the Vedic age seem to have lived and died ignorant of cats. The Sanskrit names of the animal mean "the animal of the house," "the house-wolf," "the rat-eater," "the enemy of mice." M. Pictet thinks that none of the European names for the cat belong to the old Aryan tongue. The Roman name, *catus*, signifies sly, cunning, crafty, but is traced by him back to the Syriac *gatô* and the Arabic *gitt*, and thence back to African words of which the Nubian *kadiska* is an example. This gives more evidence, such as it is, of the African origin of the animal. Some of the names, such as the Persian *puschak* and its variants, appear related to our *puss*, and are connected by M. Pictet with the Sanskrit *putchha*, tail—the creature with the waving tail. Our cat is supposed to be derived from the wild-cat—an animal which gave the name to the clan Chattan, and a title to the Duchess of Sutherland, which is said to mean "the Great Lady of the Cat." Finally, the "Saturday Review," from which we derive this gossip, expresses its admiration at the sagacity with which the cat passes a double life—"a sleek domestic favorite all day, a wild animal of unbridled impulse in the darkness of night."

**Bedouin Weddings.**—Dr. Siegfried Langer pleasantly describes in "Das Ausland" the marriage customs of the Bedouins of Es Salt, Palestine. First, as is the usage among all Semitic peoples, the bride is bought. The purchase-money is paid, half to her parents in compensation for bringing her up and supporting her, whence it is called milk-money; the other half in the form of dresses and ornaments for the bride, or of a provision for a settlement in case of divorce: and all must be paid in cash. As the time of the marriage approaches, the groom's associates collect around his house some evening and perform a wild symbolical dance with a great noise. The bride's friends, in the mean while are making her dress, which, when it is done, is paraded at the head of a procession singing praises of the beauty and accomplishments of the bride and the manly virtues of the groom. On the wedding-day the bride, if she lives in another town, is brought to her future home unveiled and on horseback, with an escort of a dozen armed men. She finds the friends of the bridegroom awaiting her, and they engage in a contest to gain the right by seizing to become her host for dinner. These contests sometimes become real fights. If, however, the bride lives in the same town with the groom, her friends serve her at the bath, and the putting on of her wedding-clothes, after which she takes her seat of honor to wait for the groom. He, in the mean time, has ridden to the nearest well for a bath, followed to the gate of the town by a procession of women bearing a figure adorned with pieces of the bride's outfit. Having performed his ablutions, he rides back, and on the way strikes with his riding-

whip the bridal doll, which is held up for the purpose. That is his part of the marriage ceremony. He then goes to his house, and the bride is brought up on horseback, thickly veiled, with much shouting. As she steps upon the threshold, she must cut in two with her whip an olive-branch which is put over the door; if she does not succeed, it is a bad sign. As she enters the room, a number of young fellows armed with switches rush upon the couple and try to give them a good thrashing. Then they all prepare for the feast. Abundant supplies of provisions are sent down to the *madari*, or Arab inn. The poor and travelers are admitted; and the bridegroom takes the seat of honor amid the congratulations of the crowd. After the feast the couple take a seat together and spend the whole evening and sometimes the next day silently receiving the presents and greetings of their acquaintances. On the third day they are permitted to begin their regular married life.

**Microscopy as a Science.**—The proper scientific position of microscopy is well set forth by Mr. Albert H. Tuttle in his address as Vice-President of the Section of Histology and Microscopy of the Montreal meeting of the American Association. The claim of microscopy to scientific consideration does not rest on anything in the perfection of its instruments and accessories or the delicacy of its manipulations, for they are mere technics, and, however important in their scientific bearing, are not science; nor on the fact that it is engaged with objects too small to be seen without the aid of the instrument, for many of those objects have their proper place in well-defined fields of science; but on the fact that there is a department, investigations in which must be carried on wholly by the aid of the microscope. This department is that of the study of cell-life, in all its bearings, in plant and animal alike. It embraces all matters relating to the protozoa and the protophyta, including particularly the ferment-organisms. To it belong all studies dealing with cell-life in the higher organisms; on the morphology of cells and the higher morphological questions treated by histological method; and on the development of cells and the structure and significance of embryonic layers and tissues.

**Two Vital Phenomena explained.**—Speaking of the paucity of births and the decrease of marriages shown in the French census returns for 1881, M. Levasseur remarked in the French Association that they ought not to occasion too much alarm, for they might be only temporary. Men married at thirty or thirty-five, and the men who were now of that age belonged to the class who served in the defense of the country in 1870 and 1871, which was decimated. If the decrease should be continuous for three or four years, it would be grave, and a new fact. Poverty had nothing to do with the decrease of births, for that was conspicuous in the richest departments, as in Normandy. M. Passy said that the same was the case in Switzerland. When a canton reached a dertain degree of wealth, the births were fewer. A kind of indolence, mingled with a care for the future, set in, and the desire began to prevail to secure an easy position with a small expenditure, and without running any risks.

## NOTES.

Dr. C. C. Abbott reports as among many interesting "finds" which he discovered in the Trenton gravels, after the heavy rains of last September, a wisdom-tooth of a man, which lay in the undisturbed gravel within a dozen feet of the spot where a mastodon's tusk, described in Professor Cook's "Geology of New Jersey," was found some years ago, buried almost as deeply as the tusk, and in a similar situation and among similar surroundings. This, he believes, proves the contemporaneity of man and the mastodon. He also describes some argillite spear-heads found in the gravels, more finished than the palæolithic, ruder than the polished implements, which he is disposed to class as the handiwork of the direct, post-glacial descendants of palæolithic man.

Dr. Th. Fuchs, of Vienna, has undertaken to show that the distribution of life at the different depths of the sea is influenced more by the differences in the quantity of light than by differences in temperature. He reasons that all the known facts of the distribution of sea-life are consistent with his view, and that some of the facts favor it more than the other one. Thus, if temperature is the controlling influence, the shore-animals of northern regions should seek the deep sea when they find themselves in warmer climates, but they are still found

near the shore. Genera which live in Arctic seas at a temperature below the freezing-point, find themselves at home in British seas at a temperature several degrees higher, and continue to be found in still warmer seas, till near the Island of Zebu, where they occur at 70° of temperature. Dr. Fuchs does not deny that heat has an influence in controlling the distribution, but he contends that it is very much less than that of light.

THE death of William Spottiswoode, President of the Royal Society, was announced by cable from London, June 27th. Dr. Spottiswoode was born in 1825, and was graduated at Oxford in 1845, as first class in mathematics. By inheritance he became Queen's printer, and managed that business through his life, but at the same time continued his studies, and became famous in mathematics, languages, and philosophy, and was active in educational matters. He contributed much that is of value to scientific journals. He was President of the Dublin Meeting of the British Association in 1878, and in that capacity delivered an address of remarkable qualities. A portrait of him and a short sketch were given in the "Monthly" for November, 1878.

MR. F. W. PUTNAM has described, in a paper before the American Antiquarian Society, a number of interesting copper implements from Mexico. These articles are now rare, because most of them have been sent to the melting-pot. The implements described by Mr. Putnam include a shapely axe from San Luis Potosi; axes from Tlacolula, Oaxaca; "hoes," with semi-lunar blades, from Teotitlan del Valle and Oaxaca; and scrapers of a little different shape, which are now in Dr. Valentini's collection and in the Peabody Museum. The exact character of many of these implements is not yet determined.

ANOTHER French expedition has started, in the steamer Talisman, to explore the depths of the Atlantic. It will begin with the coast of Morocco and the vicinity of the Canary Islands, and will go thence to the Cape Verd Islands, the red-coral fisheries of San Jago, and the desert islands of Branco and Raza, which are frequented by saurians that are found nowhere else, and will pay particular attention to the Sargasso Sea and its fauna.

DR. H. LEFFMANN has observed, in bottoms of some of the silicious geyser-waters of the Yellowstone National Park, deposits of gelatinous matter, which an analysis has proved to be nearly pure silica. It is structureless, but becomes a white opaque mass when heated and dried. Confined for some weeks with strong sulphuric acid, it shrank to about one tenth its former volume.

THE Rev. J. L. Zabriskie, of Nyack, New York, records the discovery, from observations of pods which he was keeping in his room, that the Wistaria-pod has the faculty of exploding with a very audible noise, and throwing its beans with force to a considerable distance. Two of the pods in his room thus exploded in succession. One of the beans was thrown to a distance of sixteen feet, and rebounded four feet. If it had been ejected with the same force from the position in which it grew on its native vine, it would have flown for a distance of at least thirty feet.

PROFESSOR W. P. BLAKE has found native lead and minium occurring in galena, near Bellevue, Idaho. The native lead is in small, rounded masses or grains of an eighth or a quarter of an inch in diameter, and sometimes in reniform bunches weighing an ounce or more. The minium is generally found incrusting it.

THE efficiency of oil to temper the rage of the waves in storms at sea is now generally recognized, and it is becoming the practice for vessels to take oil with them to be used in this way in cases of extremity. The ship Glamorganshire was recently saved in a tempest by the timely use of oil; while a powerful steamer, the Navarre, neglecting it, was swept by the waves and went down in the North Sea, on the 6th of March, with those on board. The oil operates by preventing the waves around the vessel from breaking, and converting them into a heavy swell. "Chambers's Journal" remarks that "ships that leave port unfurnished with oil, in case of emergency, are defrauded of one of their chief elements of safety."

M. RICHET, Professor of Clinical Surgery at Paris, has been chosen to the seat in the French Academy of Sciences made vacant by the death of M. Sedillot.

THE greenhouses of the Dutch gardeners have been recently infested by a myriapod, heretofore unknown, called the *Fontaria gracilis*, which has the singular faculty of emitting a strong odor of prussic acid when attacked. A chemist of the country, M. Guldensteeden-Egeling, has ascertained that the animal really fabricates and secretes hydrocyanic acid. This substance has hitherto been regarded as exclusively of vegetable origin.

M. MARGIS, of Paris, has succeeded in obtaining oxygen directly from the atmosphere by dialysis. By forcing air through a series of membranous bags prepared by immersing taffeta in ether, sulphide of carbon, or alcohol, and covering with a fine layer of caoutchouc, he has secured an increase of the percentage of oxygen in respect to nitrogen till the fourth bag gives ninety-five per cent of pure oxygen.

SIR WILLIAM E. LOGAN.